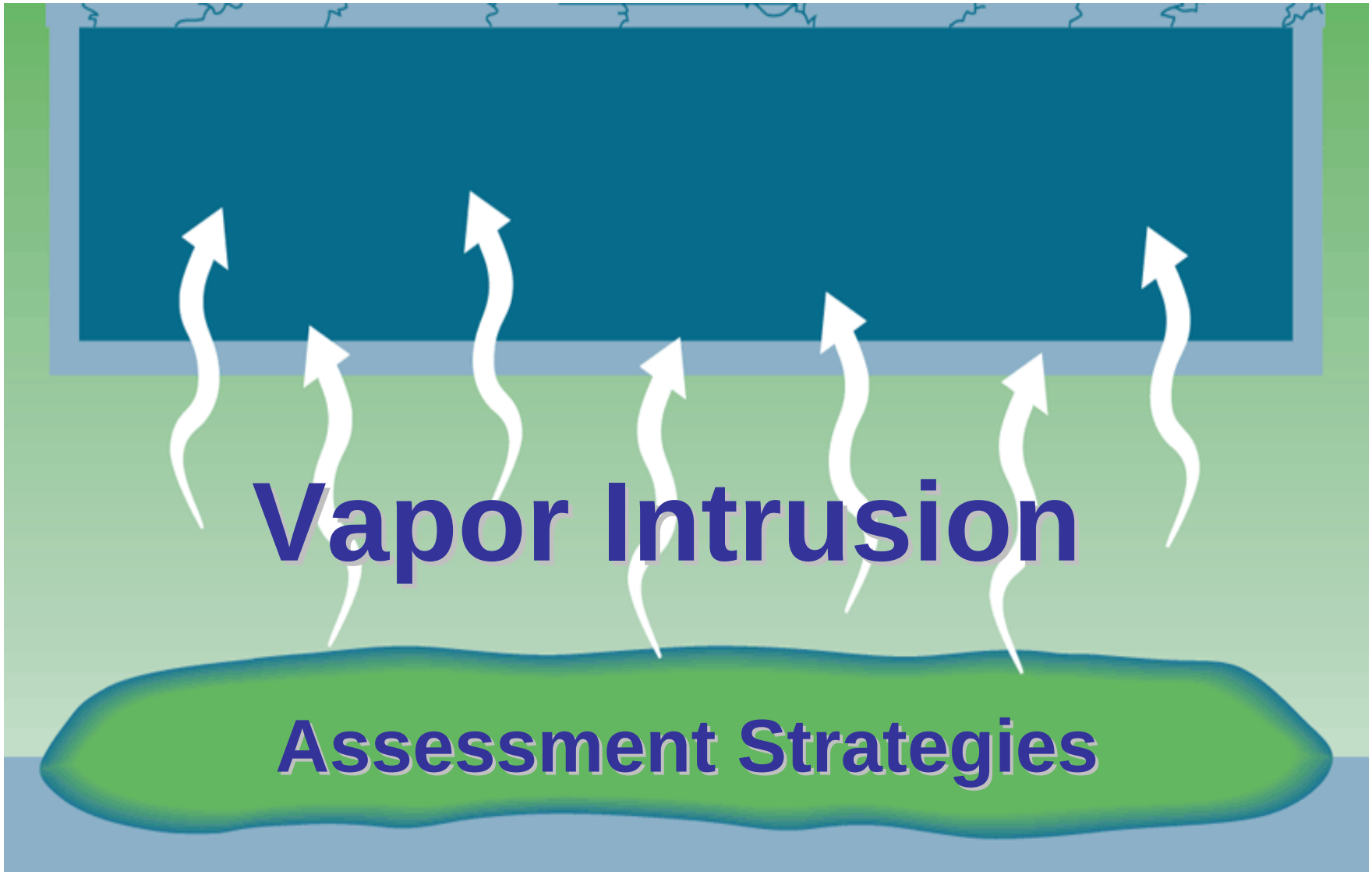
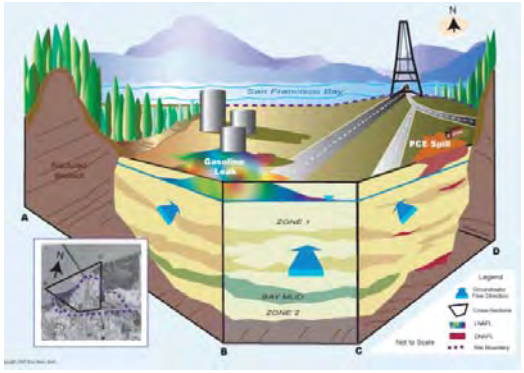

Vapor Intrusion
Assessment Strategies

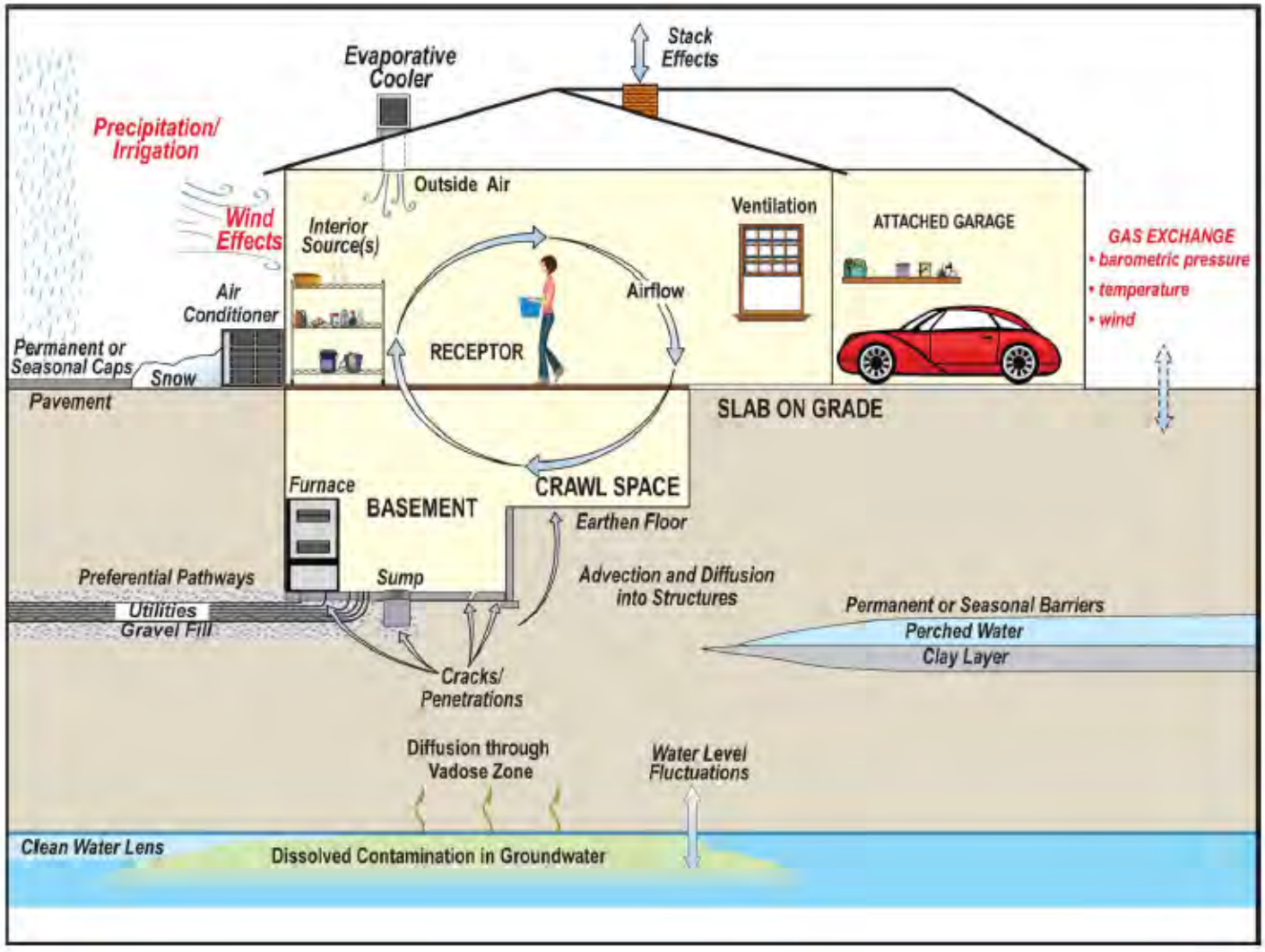
Developing the Conceptual Site Model

- Important first step in assessing contaminated sites
- It's a picture and narrative of the site and it's contamination
  - How it got there
  - Is it migrating or degrading
  - It's distribution across the site
  - Who might be exposed and at what levels



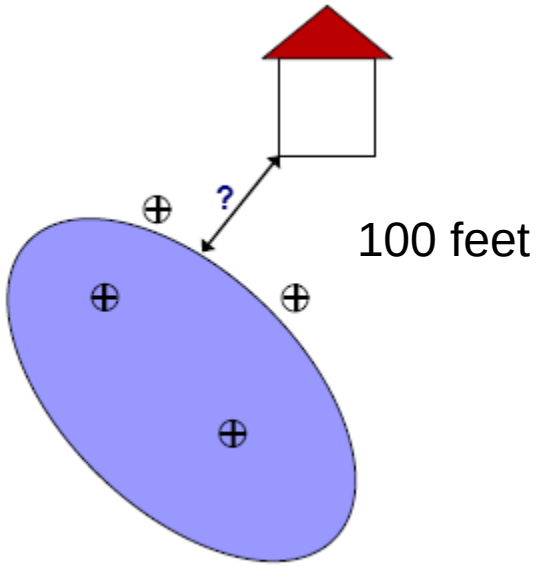
  - Site-specific information on source areas, contaminant properties, stratigraphy, hydrogeology, exposure pathways, structures and potential receptors.
  - Investigations for vapor intrusion often include collecting samples of soil, groundwater, soil vapor, and/or indoor air.

VI Conceptual Site Model (CSM)



When is Vapor Intrusion a Concern?

- VI is a potential concern at any building (existing or planned) located near soil or groundwater contaminated with VOCs.



- EPA defines near as contamination within 100’ (laterally or vertically) of buildings, unless there is a conduit that intersects the soil gas migration route that would allow soil gas to migrate further than 100’

Residential Screening Levels For Indoor Air Samples

Chemical	Indoor Air ug/m^3	Molecular Weight	24.5/Molecular Weight	Indoor Air ppbv
Tetrachloroethene (PCE)	0.41	166	0.1476	0.0605
Trichloroethene (TCE)	1.2	131	0.187	0.2244
1,2-dichloroethene	37	97	0.2526	9.345
Vinyl chloride	0.16	63	0.3889	0.0622
Benzene	0.31	78.1	0.313	0.0970
Toluene	5200	92	0.266	1384.8
Ethylbenzene	0.97	106	0.231	0.2241
Xylene	100	106	0.231	23.11

“Exterior” Investigations

- Map the contamination
- Identify buildings with potential VI risk
- Identify target compounds
- Collect site specific information
- Minimize inconvenience to building occupants and owners

“Bound the scope of the problem”

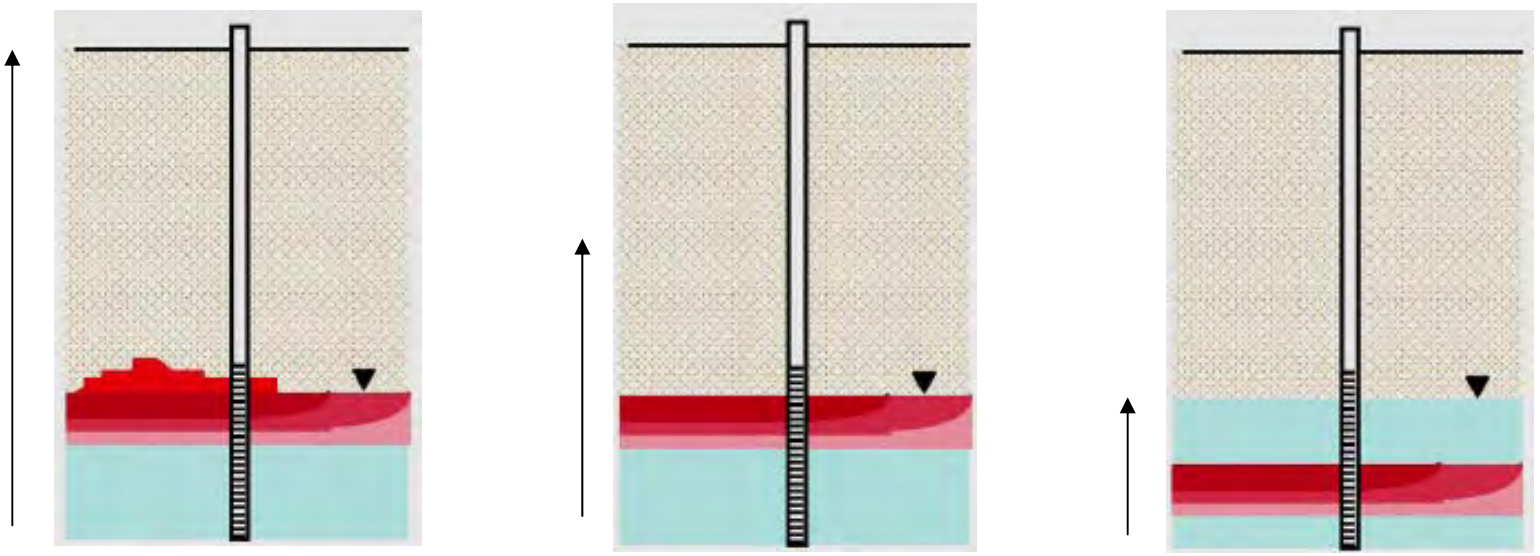
Groundwater Sampling

- Sampling Options for the Assessment of Vapor Intrusion

Options	Pros	Cons
Groundwater Sampling 	Indicates if a contaminant source in the unsaturated zone is contaminating gw. Helps assess potential down gradient impacts of vapor intrusion. Can be performed at properties having no buildings.	Does not represent vapor concentrations at the source. Requires utility clearance to drill boring for monitoring well. Requires access agreement and permit.

Groundwater Sampling

- Issue: Proper sampling and interpretation of vertical profile of chemicals in groundwater is critical
  - Each scenario below could give the same groundwater concentration, but vastly different soil vapor concentrations.

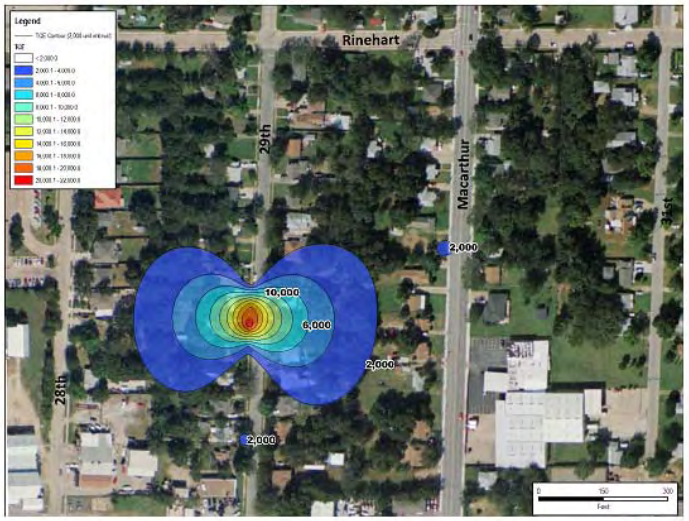


Soil Sampling

- Sampling Options for the Assessment of Vapor Intrusion

Options	Pros	Cons
Soil Sampling 	Search and delineate the extent of contamination in the unsaturated zone. Can be performed at properties having no buildings.	VOC loss on sampling is significant. Vapor concentrations may be underestimated. Requires utility clearance to drill boring. Requires access agreement and permit.

Soil Gas Sampling



- Method:
  - Active
  - Passive

    Active Method Most often used for VI Investigations, but passive is becoming much more common
- Location:
  - Exterior
  - Near building
  - Subslab

    Subslab soil gas sampling is most often used for VI Investigations

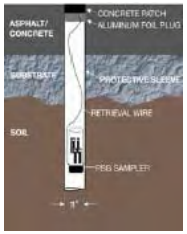
Soil Gas Sampling

- Sampling Options for the Assessment of Vapor Intrusion

Options	Pros	Cons
Active Soil Gas Sampling 	Near the source, it may provide an estimate of source vapor concentration. Near buildings it can be performed without entering the structure. Can be performed at properties without buildings.	Significant lateral and vertical spatial variability. Results may not be representative of vapor concentrations under buildings. Requires utility clearance to drill boring. Requires access agreement and permit.

Soil Gas Sampling

- Sampling Options for the Assessment of Vapor Intrusion

Options	Pros	Cons
Passive Soil Gas Sampling   	Can cost effectively identify hot spots or areas needing additional investigation. Easy to perform. Works better than other soil gas methods in low permeability soils. Can be performed at properties having no existing buildings.	Yields semi-quantitative results – higher detection limits. Data reported in mass not concentration. Can be affected by weather. There is at least a 2-3 week delay in results.

“Interior” Investigations

- Working with the “Homeowner” requires time and effort
  - Access agreements, factsheets, meetings, visits on evenings and weekends, etc.
- Requires removal of potential interior or lifestyle sources
- Collect samples and compare with controls
  - Subslab, ambient, etc.
- Risk communication
  - What do the data mean?

Sub-Slab Soil Gas

- Sampling Options for the Assessment of Vapor Intrusion

Options	Pros	Cons
Subslab sampling of vapors beneath buildings 	Establishes vapor concentration directly below indoor air space. Closest subsurface sample to receptors. Used in conjunction with indoor air samples can help resolve lifestyle sources of vapors in indoor air.	Method is intrusive. Requires access agreement and entry into buildings. Cannot be performed at properties without buildings.

Indoor Air

- Sampling Options for the Assessment of Vapor Intrusion

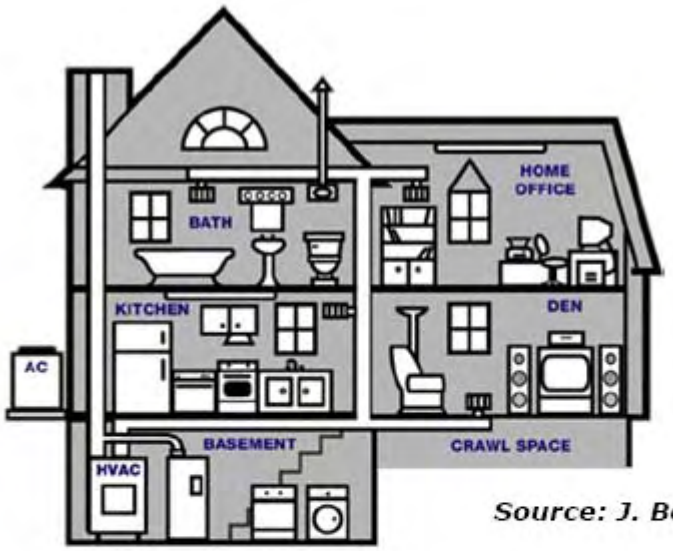
Options	Pros	Cons
Indoor air sampling 	Actual indoor air concentration, no modeling, no attenuation factors Relatively quick, no drilling or heavy equipment Less spatial variability than soil gas	Indoor contaminants and lifestyle sources may bias the data. Method is intrusive. Requires access agreement and entry into buildings. Cannot be performed at properties without buildings. More temporal variability.

Background Sources

- Background refers to sources not attributable to releases from a site.
- Background sources in some cases may exceed risk based levels in indoor for some common VOCs.
- Background sources may be inside the building or present in ambient outdoor air.

Background Sources

Important: Conduct a building survey and cleanout before sampling



Source: J. Boyer, NJDEP

- Consumer Activities
- Household Products
- Building Materials & Furnishings
- Ambient (outside) Air

Common Household Sources of Background Indoor Air Contamination

Acetone	Formaldehyde
Benzene	n-Heptane
Bromomethane	n- Hexane
2-Butanone (MEK)	Methylene chloride
Chlorobenzene	Methyl isobutyl ketone
Chloroethane	Methyl tert butyl ether
Chloroform	Styrene
Cyclohexane	1,1,2,2-Tetrachloroethane
1,4-Dichlorobenzene	Tetrachloroethene (PCE)
Dichlorodifluoromethane	Toluene
1,1-Dichloroethane	1,1,1-Trichloroethane
1,3-Dichloropropene	Trichloroethene (TCE)
Ethylbenzene	Xylenes, total

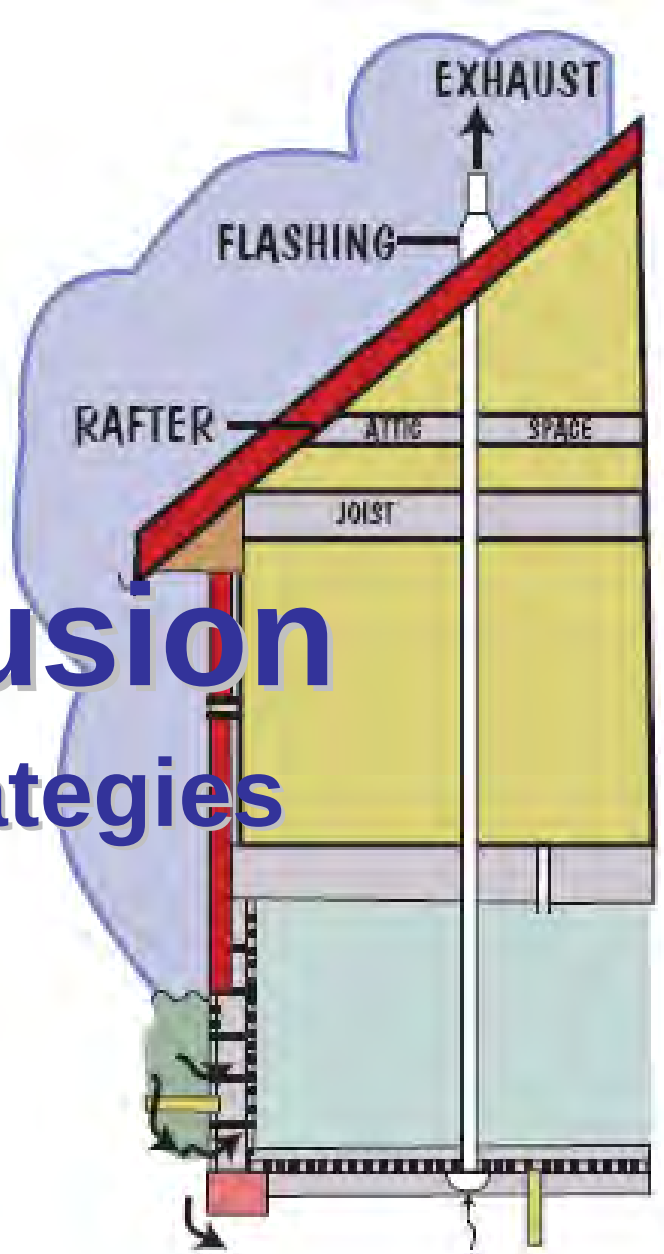
http://www.state.nj.us/dep/srp/guidance/vaporintrusion/

Soil Gas and Indoor Air Method Guidance

Parameter	Method	Sample media/storage	Description[b]	Method holding time	Reporting limit[c]
		VOCs			
BTEX, MTBE, TPH	TO-3	Tedlar bag or canister/ambient temperature	GC/FID	30 days for canister	1–3 µg/m^3
Nonpolar VOCs	TO-14A	Canister/ambient temperature	GC/ECD/FID or GC/MS	30 days for canister	1–3 µg/m^3
Polar and nonpolar VOCs	TO-15	Canister/ambient temperature	GC/MS	30 days for canister	1–3 µg/m^3
Low-level VOCs	TO-15 SIM	Canister/ambient temperature	GC/MS	30 days	0.011–0.5 µg/m^3
Polar and nonpolar VOCs	TO-17[d]	Sorbent tube, chilled <4°C	GC/MS	30 days	1–3 µg/m^3
VOCs	8021B modified[e]	Syringe, Tedlar bag, glass vial/ ambient temperature	GC/PID	On-site analysis or up to 30 days (depending on container)	10–60 µg/m^3
VOCs	8260B modified[e]	Syringe, Tedlar bag, glass vial/ ambient temperature	GC/MS	On-site analysis or up to 30 days (depending on container)	50–100 µg/m^3
		SVOCs			
SVOCs	TO-13A[d]	High-volume collection (may require large sample volume, e.g., 300 m^3)/PUF/XAD media, chilled <4°C	GC/MS	Extracted within 7 days of collection and analyzed within 40 days of extraction	5–10 µg/sample
Low-level olycyclic aromatic hydrocarbons (PAHs)	TO-13A SIM[d]	High-volume collection (may require large sample volume, e.g., 300 m^3)/PUF/XAD media, chilled <4°C	GC/MS	Extracted within 7 days of collection and analyzed within 40 days of extraction	0.5–1 µg/sample

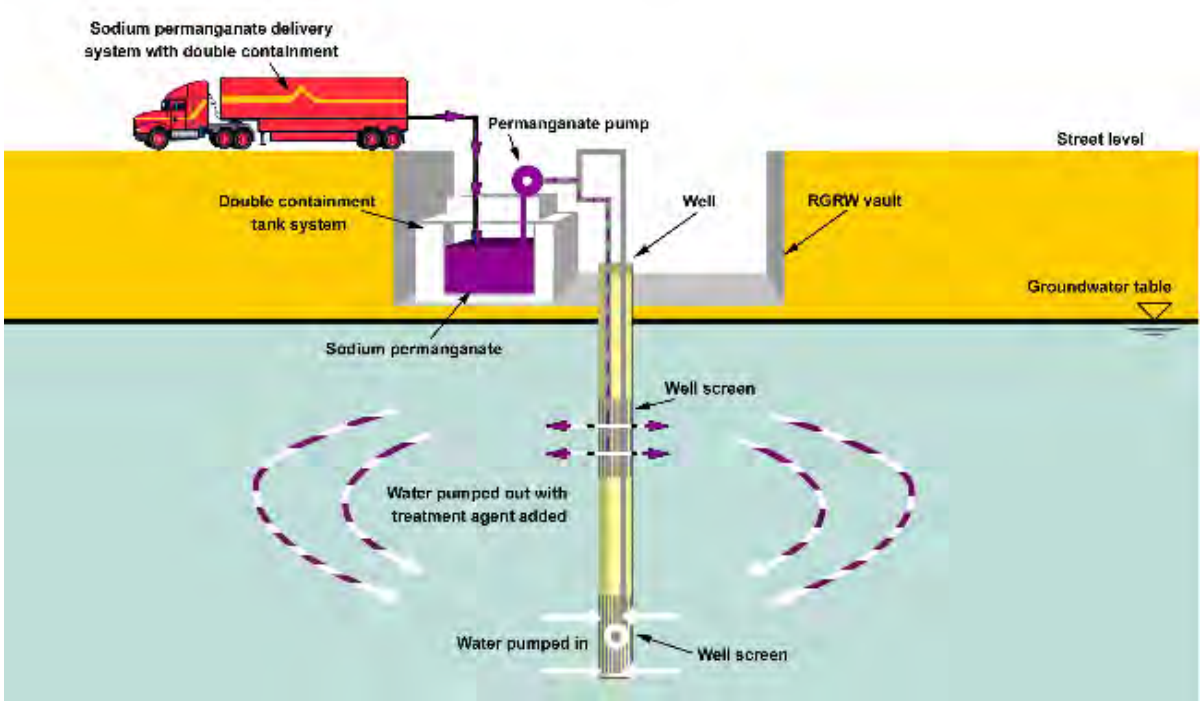
Vapor Intrusion

Mitigation Strategies

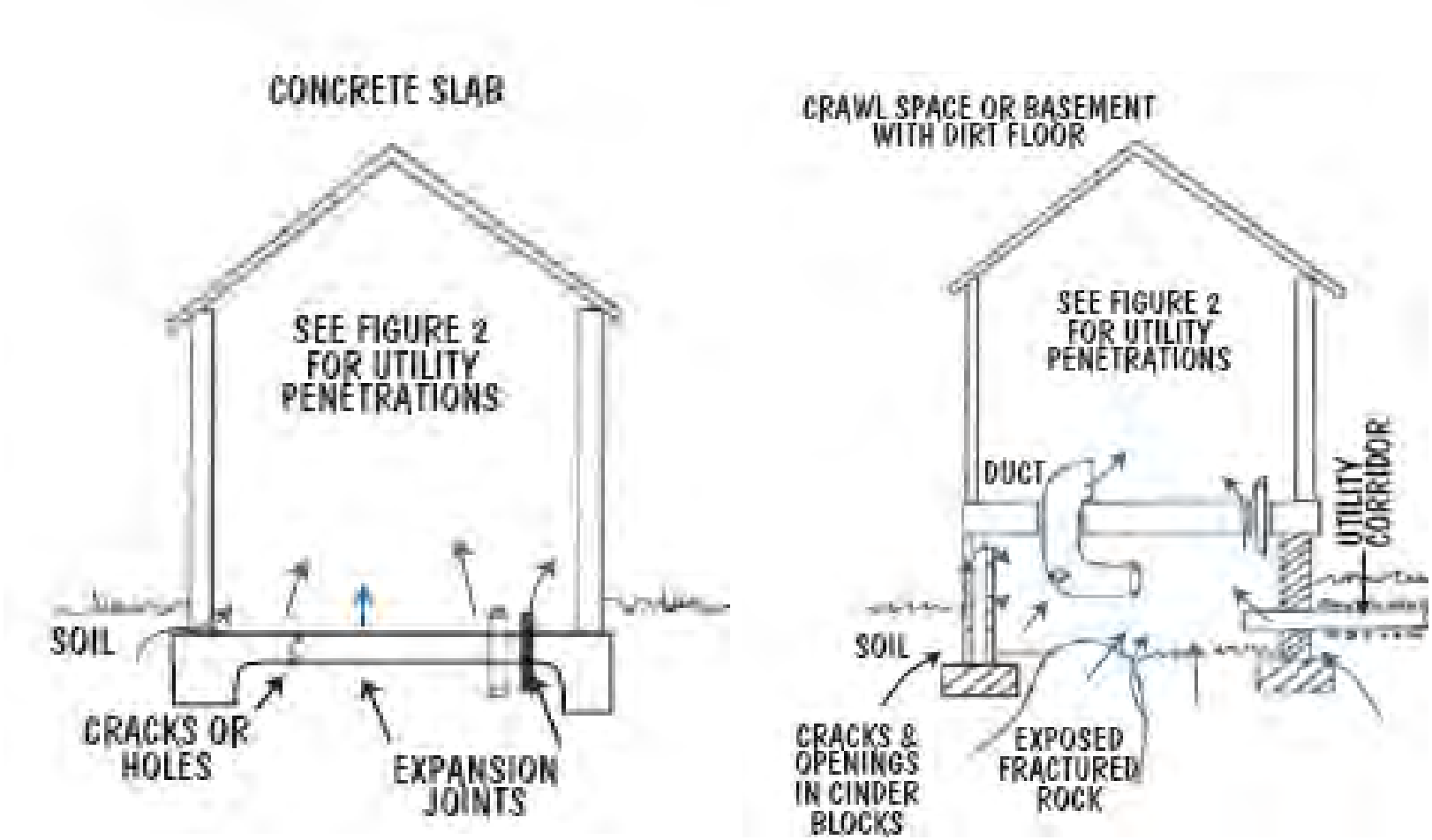


Options

- Eliminating the source of contamination can be more protective of human health in the long run than mitigation alone, but it may not eliminate the risk quickly, be technically feasible or cost effective.



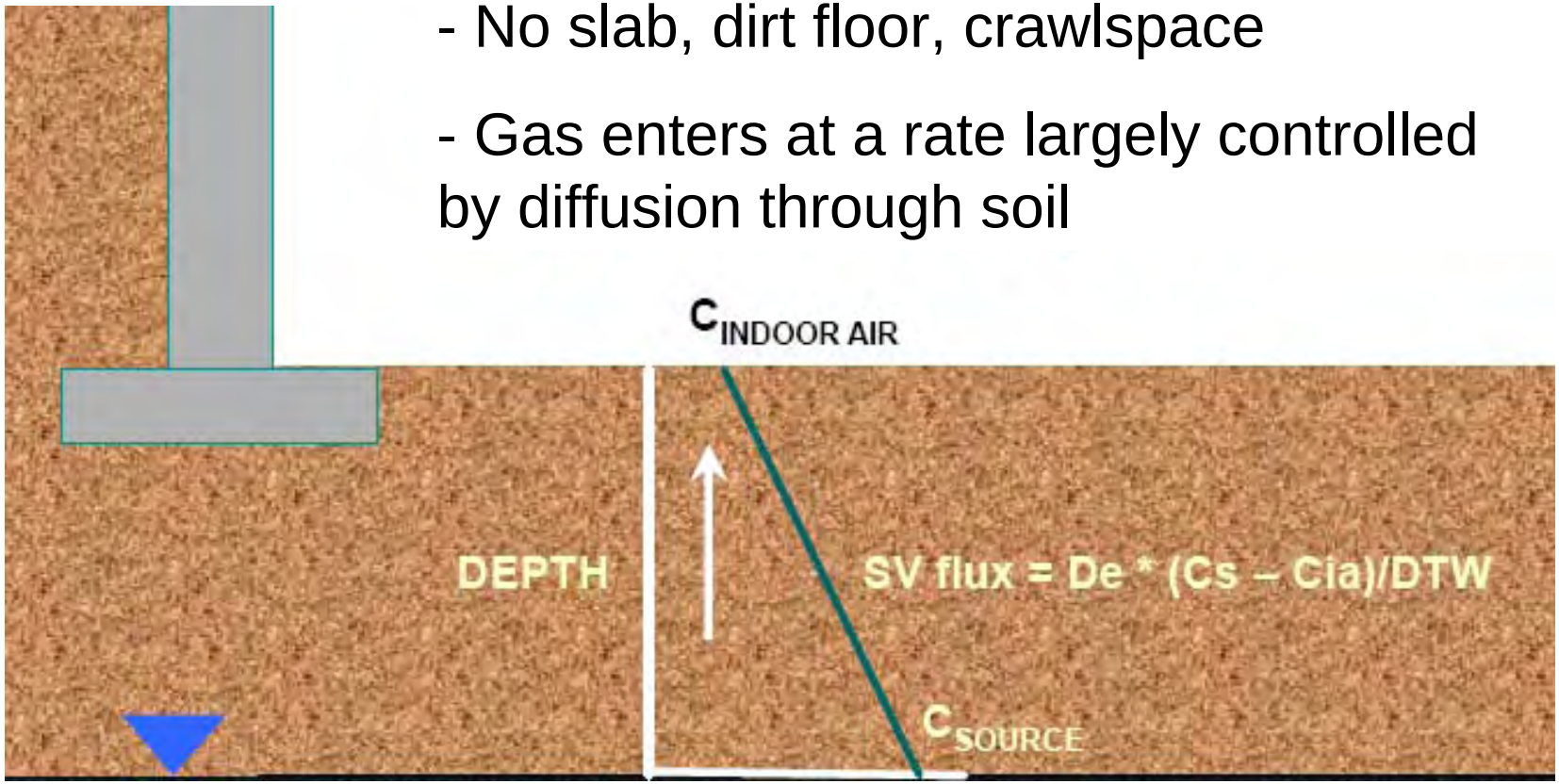
Routes of Entry



Mitigation Concepts

- No slab, dirt floor, crawlspace

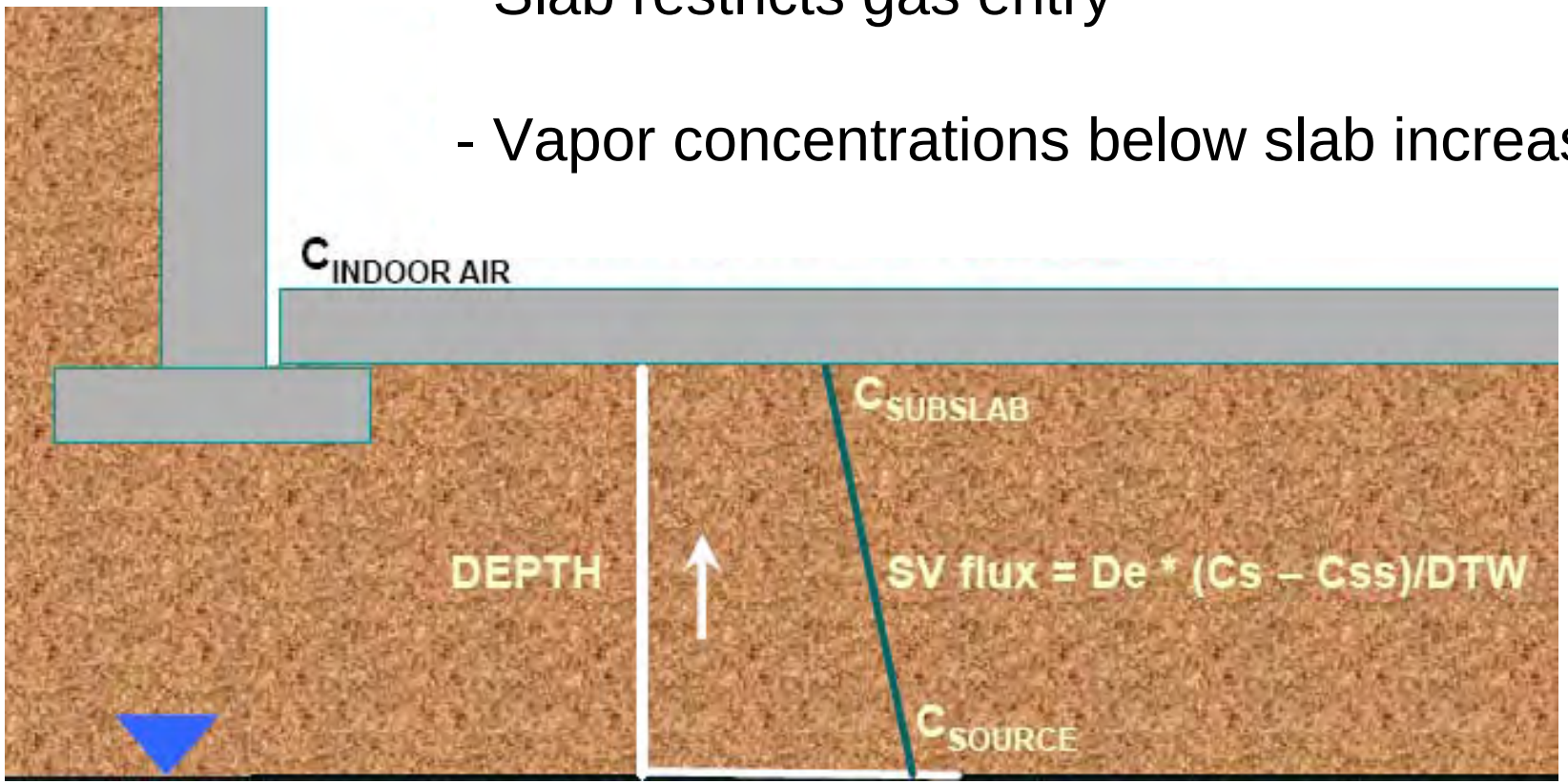
- Gas enters at a rate largely controlled by diffusion through soil



Mitigation Concepts

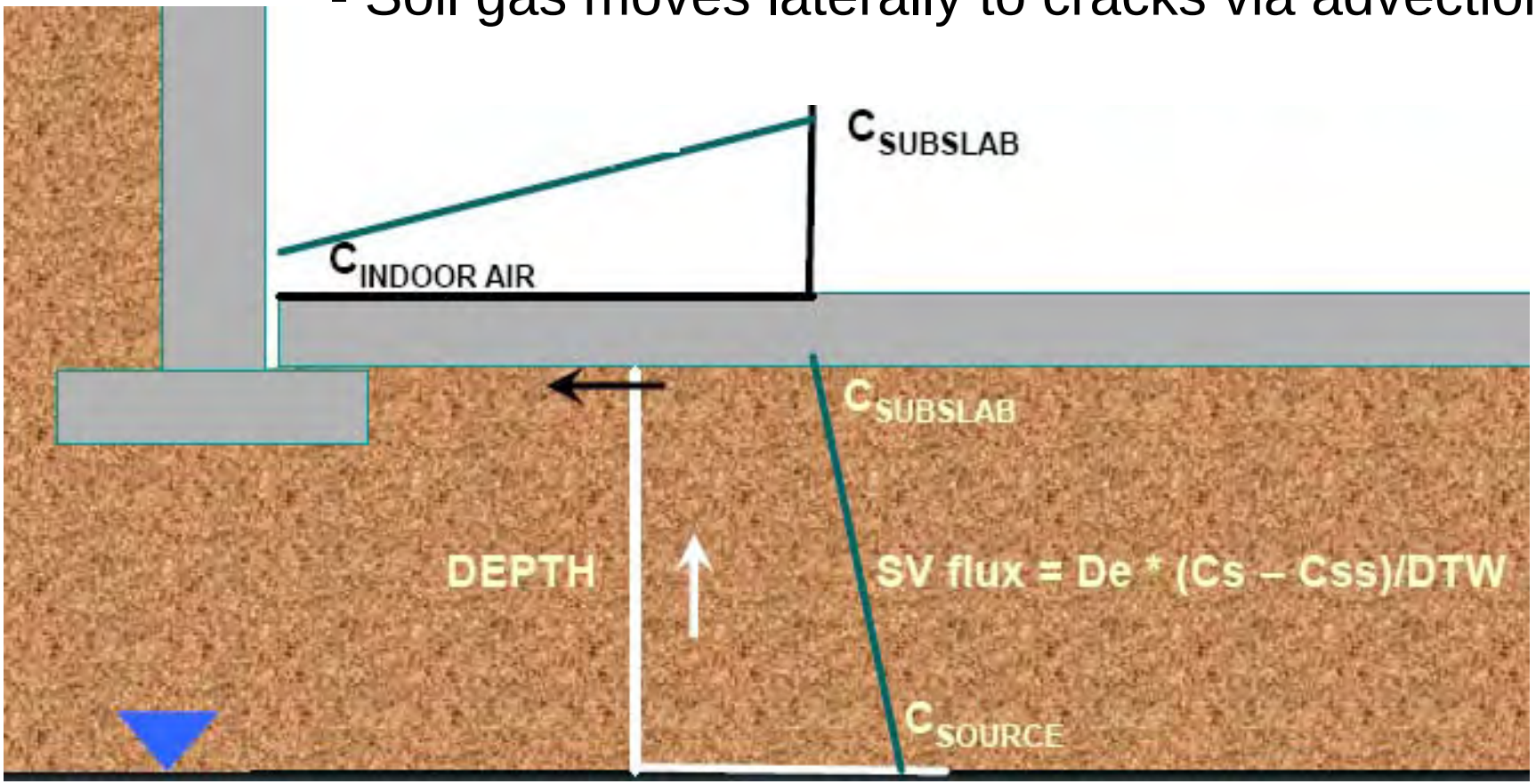
- Slab restricts gas entry

- Vapor concentrations below slab increase



Mitigation Concepts

- Soil gas moves laterally to cracks via advection

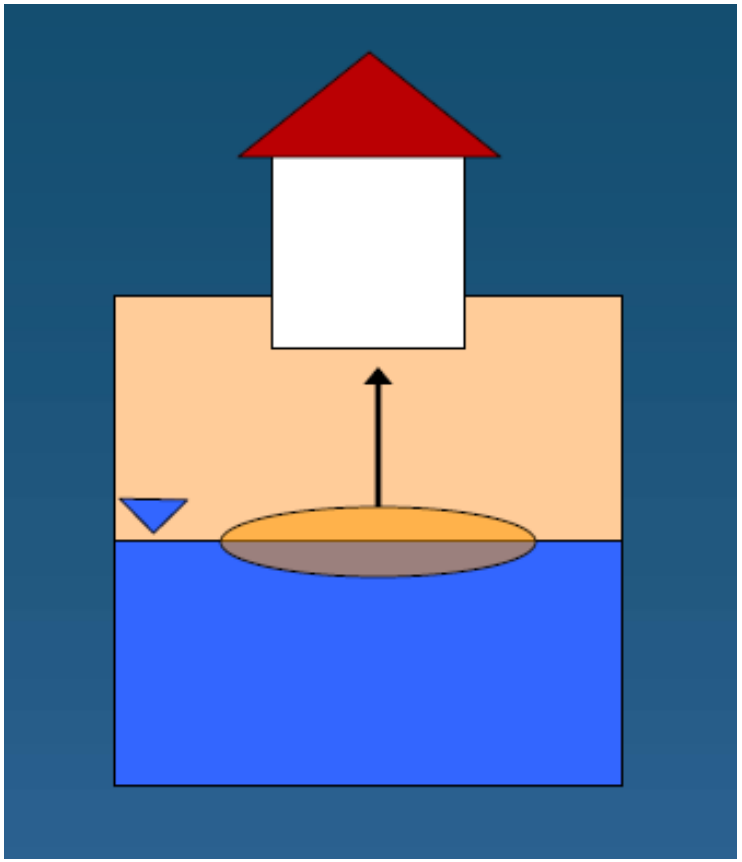


Three Basic Approaches To Mitigation

1) Cleanup Soil and Groundwater

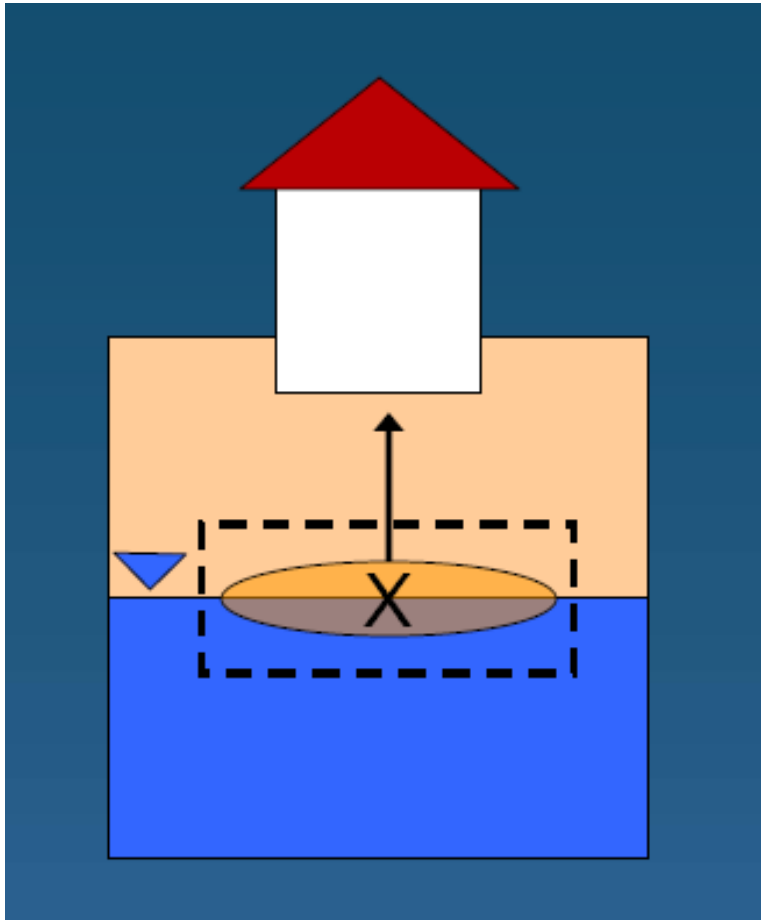
2) Invoke Institutional Controls

3) Install Building Mitigation Systems



Soil and Groundwater Remediation

Eliminate the Source of Vapors



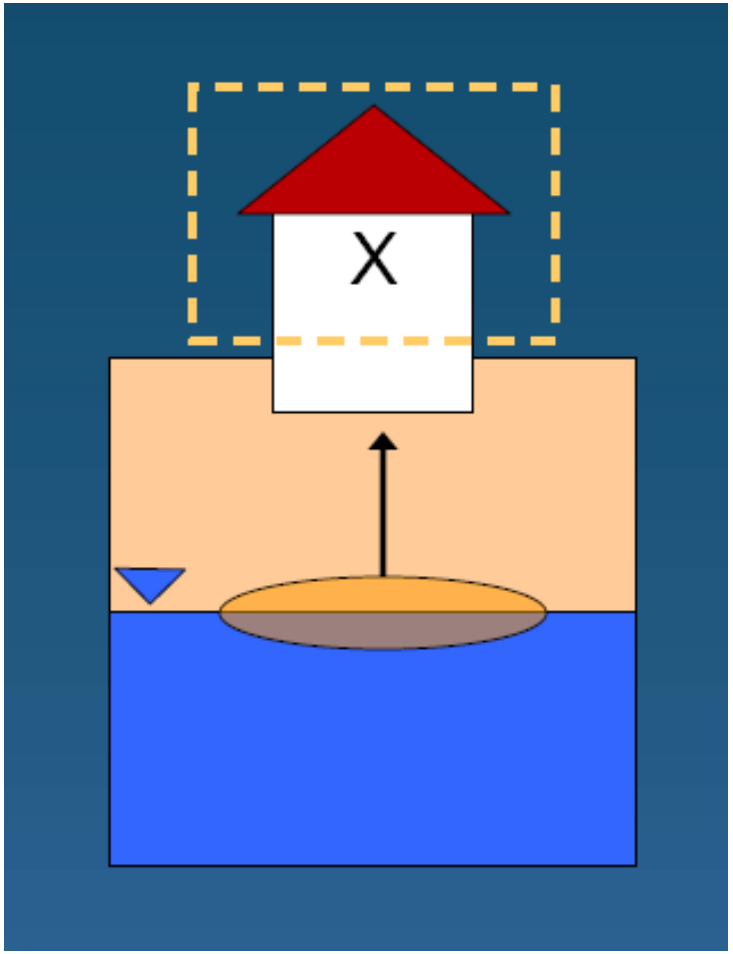
Institutional Controls

Prevent exposure to vapors by:

- **Preventing buildings being built**

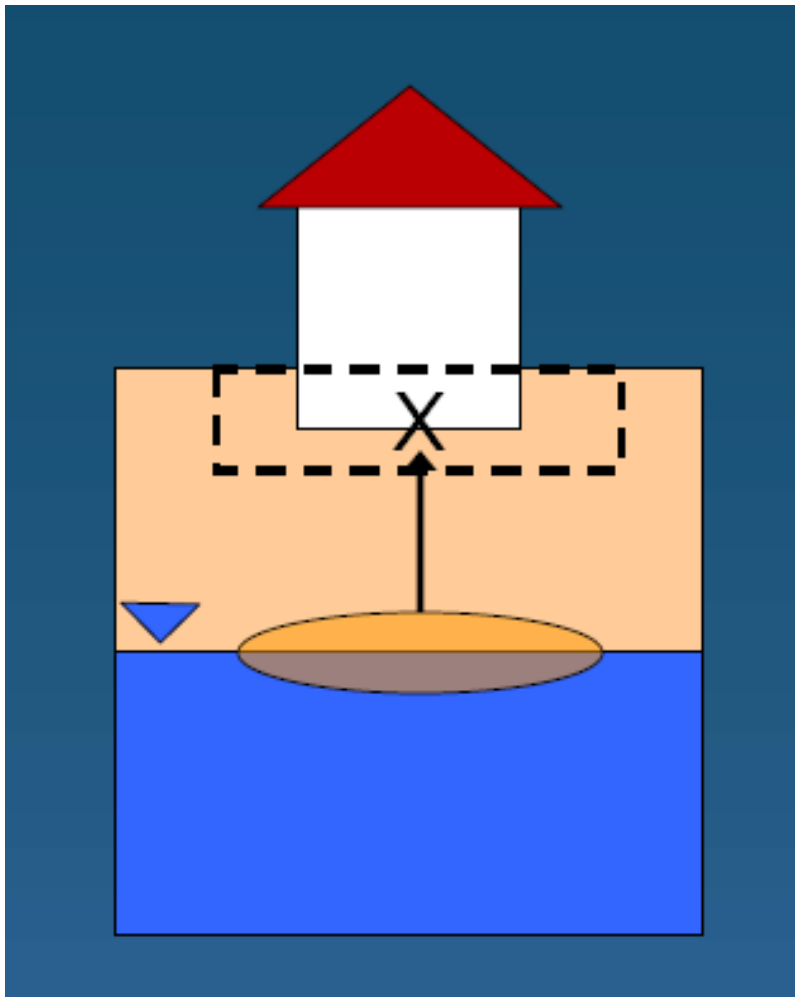
- **Require controls in New Buildings**

- **Restrict Occupancy Use**



Building Controls

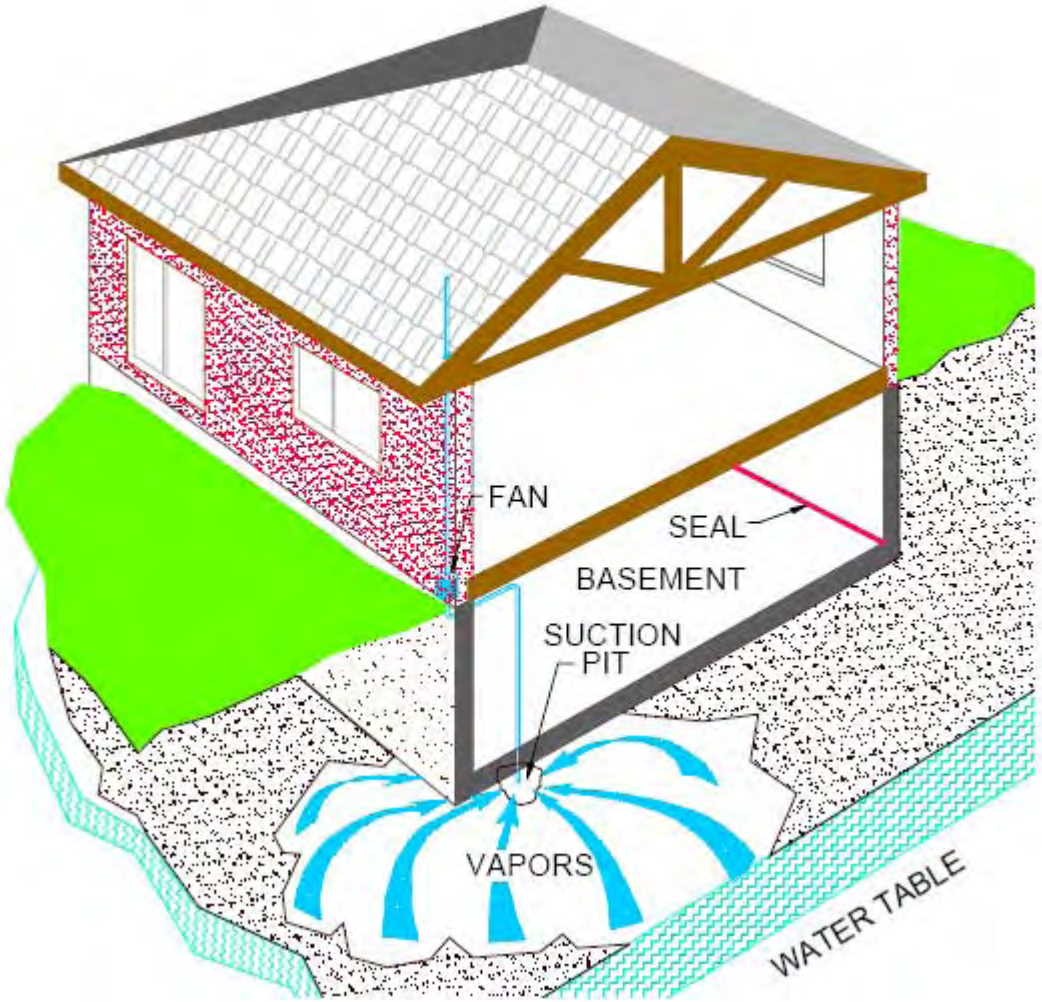
Prevent Entry of Vapors Into Buildings



Building Mitigation Approaches

- Sub-Slab Depressurization
- Sub-Membrane Depressurization
- Sub-Slab Pressurization
- Building Pressurization
- Indoor Air Treatment
- Passive Barriers

Sub-Slab Depressurization



Intercepts vapors prior to building entry

Same as “radon” system

Most commonly used method for radon and VOC control

Highly effective in most Settings

Up to 99.5%+ reductions

Sub-Membrane Depressurization

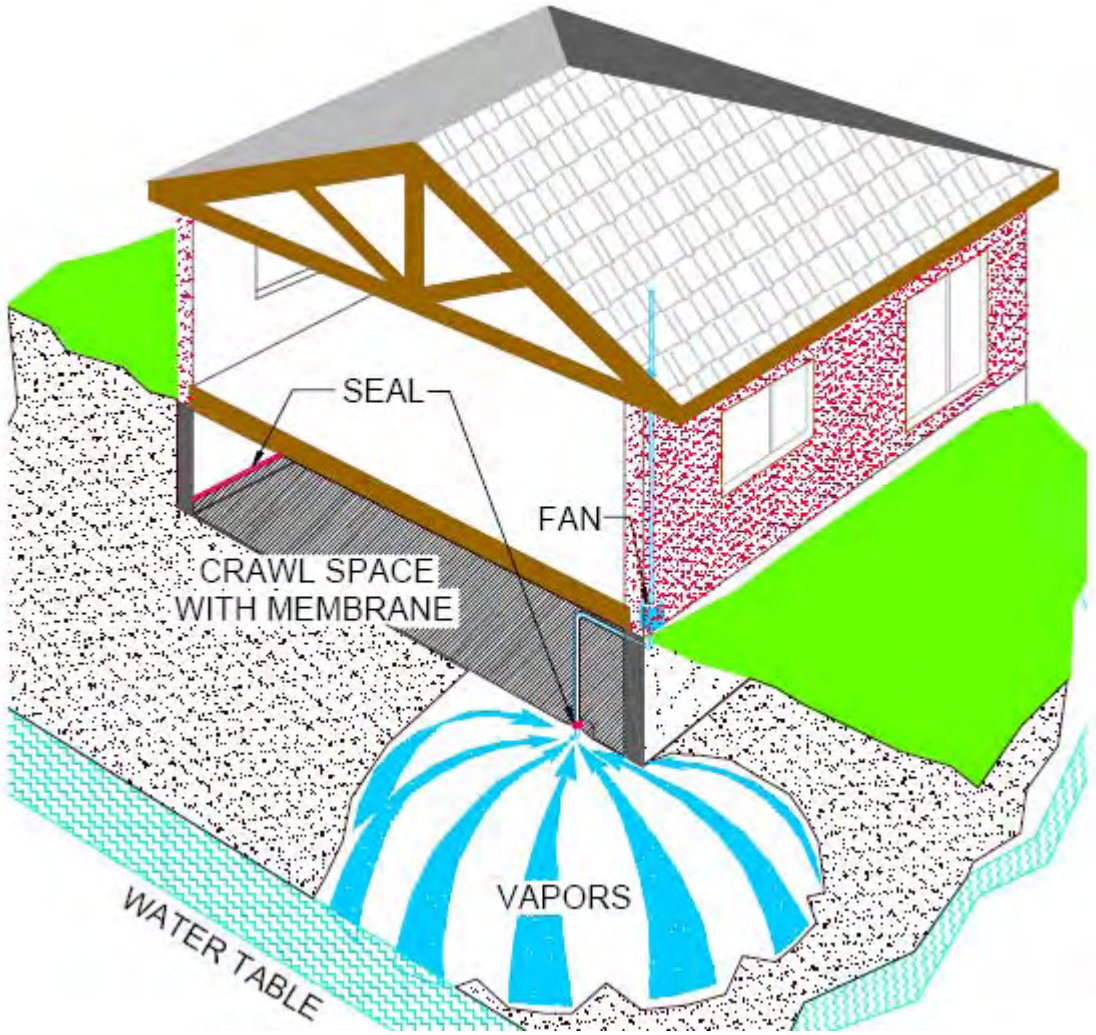
Same concept as SSD

Good foundation seals critical

More susceptible to damage (liner)

Highly effective in most Settings

Up to 99.5%+ reductions

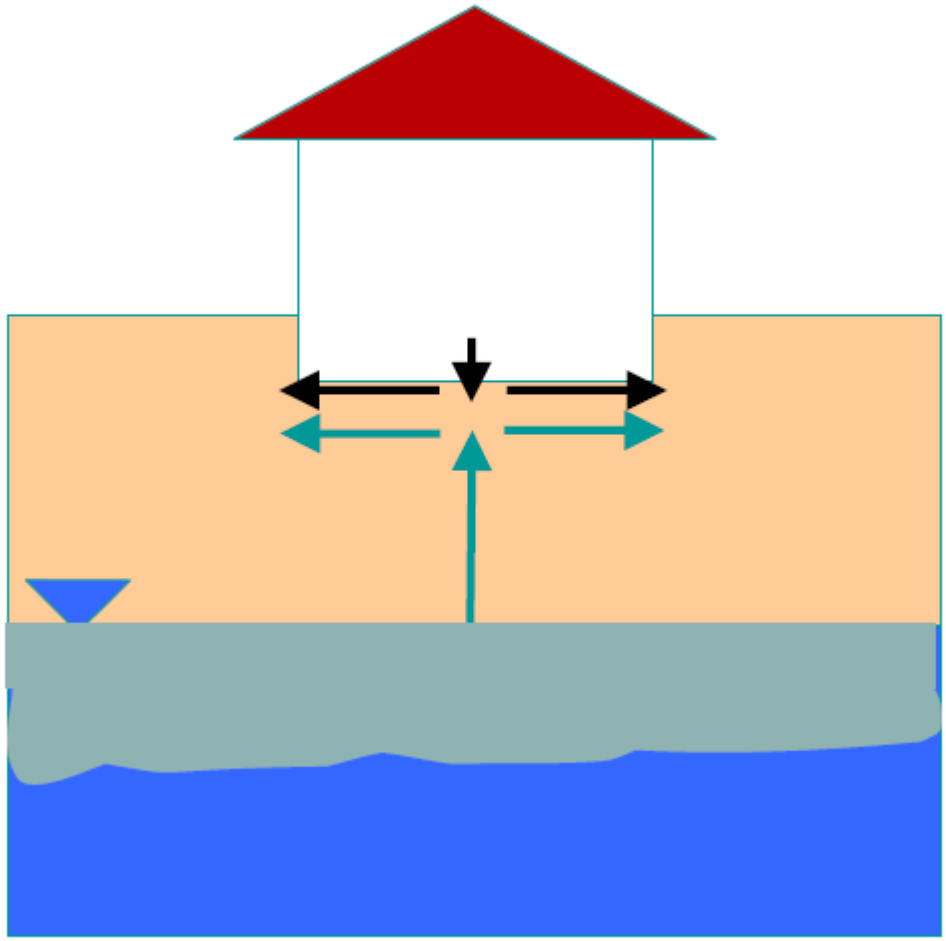


Sub-Slab Pressurization

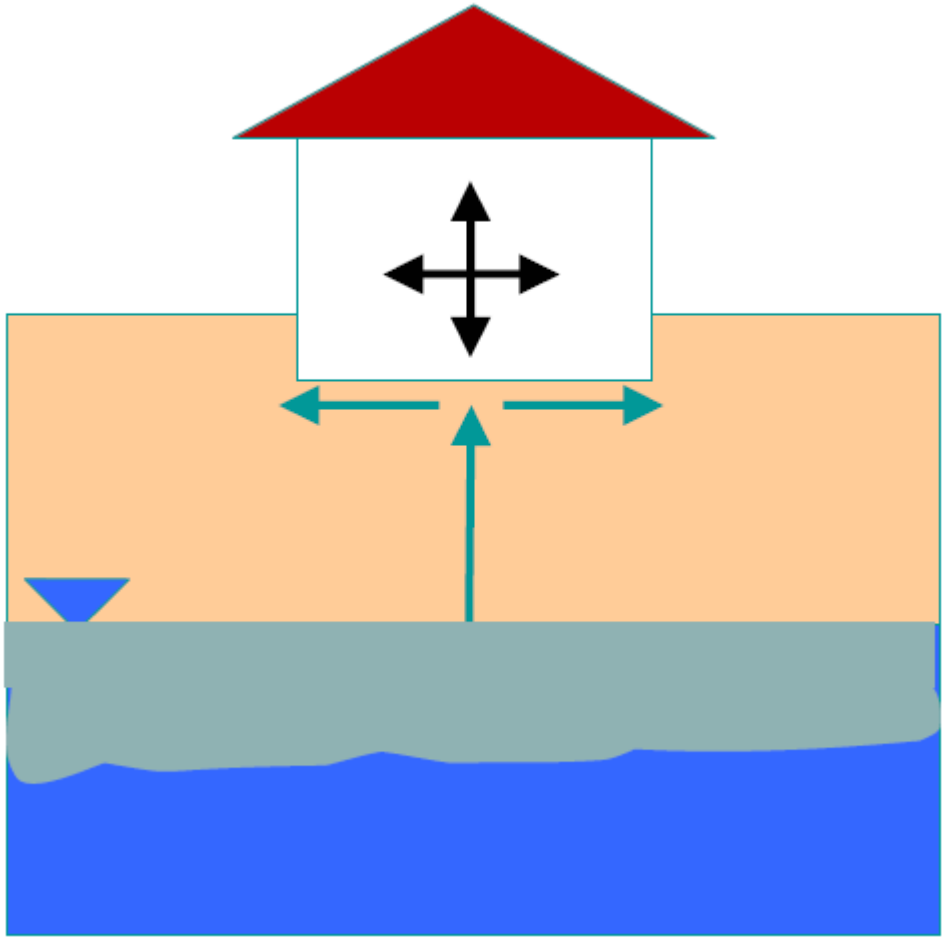
Positive pressure below slab deflects soil vapors

Not commonly applied

Less effective than SSD in most settings



Building Pressurization



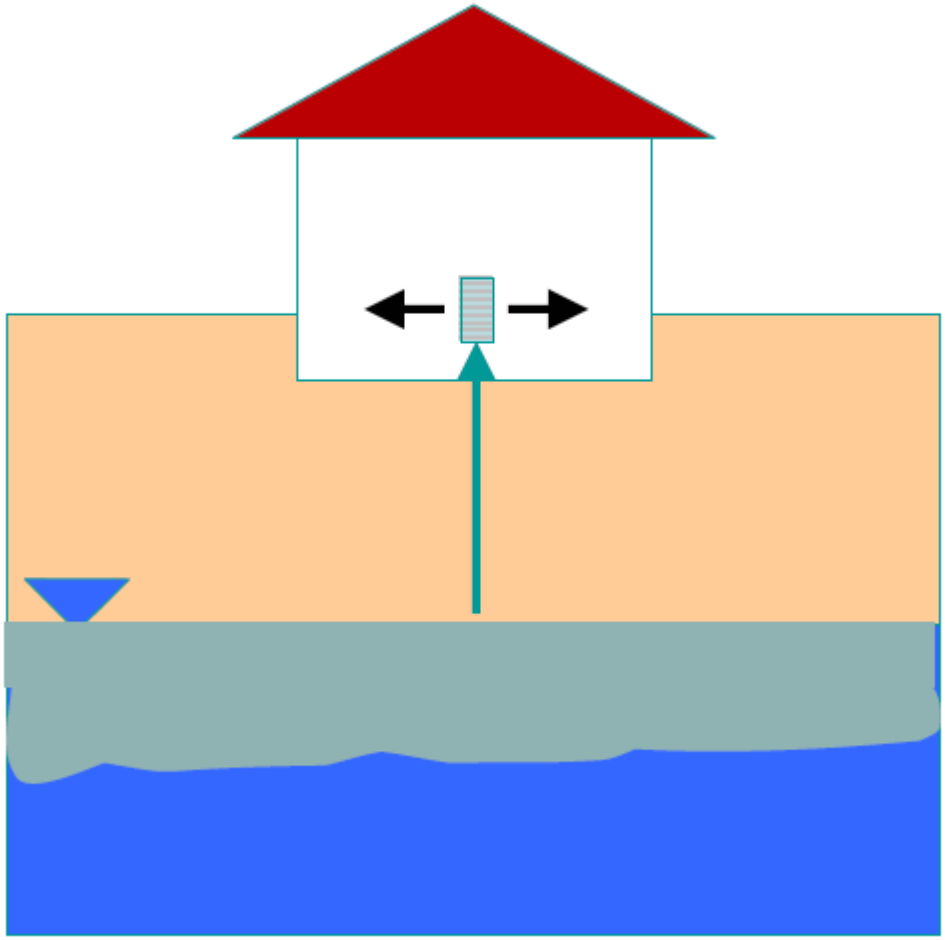
Positive pressure in building prevents vapor entry

Not commonly used

Potential high energy cost due to air and heat loss

Less effective than SSD

Indoor Air Treatment



Air cleaned after entry into House

Carbon typically used

Not commonly applied

Less effective

Higher costs

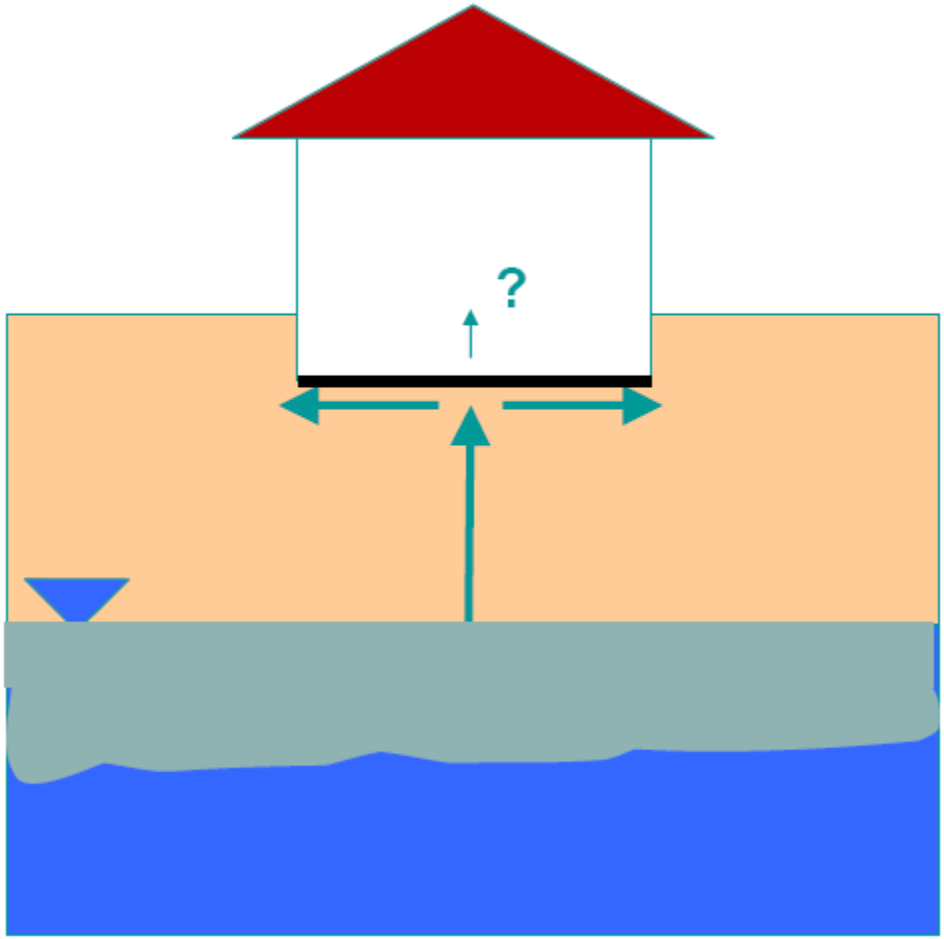
O&M intensive

Passive Barriers

Synthetic barrier placed below, slab to prevent vapor entry

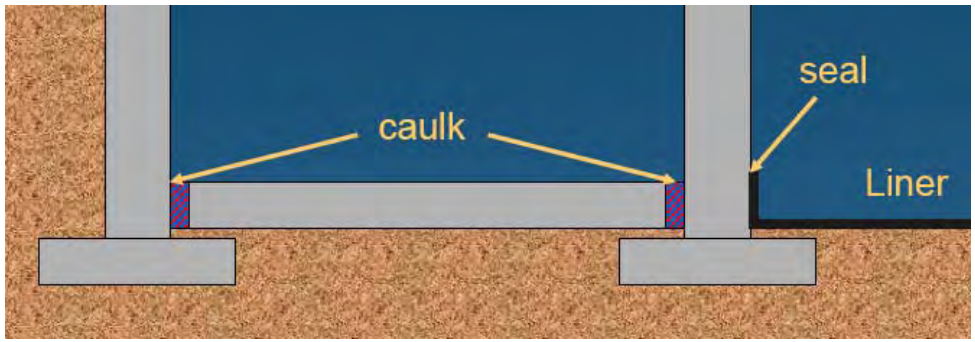
Typically considered for new construction, but may be Retrofitted

Liners vary from thin plastic sheets to thick HDPE liners, spray-on elastomers, etc.



Examples

Sealing
Cracks



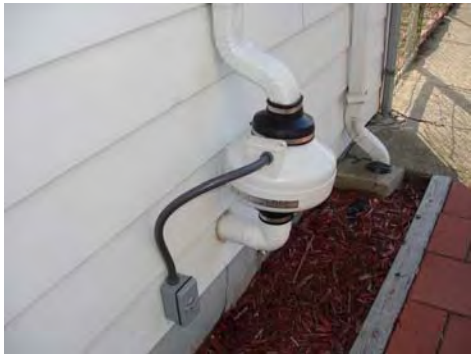
Spray on barriers – Liquid Boot

Examples

Active subslab depressurization

Examples

Active crawlspace sub-membrane depressurization



Passive crawlspace membrane

EPA Region 6 RCRA
Vapor Intrusion Investigations

Case Studies

EPA Region 6

Region 6 RCRA Program Vapor Intrusion Investigations

- Limited VI Data for EPA Region 6
- Limited formal State policy or guidance
- Large off site groundwater plumes
- Congressional interest
- Community interest
- Funding issues

Investigation Objectives

- Sampling was intended to determine if there is a completed pathway from groundwater to indoor air.
- Sampling was limited to an area with the highest groundwater concentration.
- Sampling was not intended to further delineate any soil or groundwater contamination (data were already available for the facilities being reviewed).

Questions We Were Trying To Answer

- Does subsurface vapor exist below homes or commercial buildings (slab or crawlspace)?
- If Subsurface vapor does exist, is it entering the residence or commercial building?
- If vapor contamination is found in the residence or commercial building, is it from the subsurface or elsewhere (i.e., lifestyle or ambient)?
- If vapor intrusion is present what are the risks
  - how to address – additional monitoring, source remediation, mitigation?

Sites Investigated

- EPA Region 6 investigated five sites as a part of our study
  - Kelly AFB, San Antonio, TX
  - England AFB, Alexandria, LA
  - Delfasco Forge site, Grand Prairie, TX
  - Parker Solvents, Little Rock, AR
  - Mueller Copper Tubing Site, Wynn, AR

General Sampling Strategy / Approach

- Subslab Sampling
  - Installation of sampling ports into foundations
  - Tedlar bag samples (screen)
  - Summa canister samples
  - Decision on whether to collect indoor air samples and their locations

General Sampling Strategy / Approach

- Vapor Screening with TAGA

- Confirmation Sampling with Summa Canisters
  - Clean out homes from lifestyle sources of VOCs
  - Screen outdoor crawlspace openings
  - Screen indoor crawlspace openings
  - Screen indoor living space
  - Screen outdoor ambient air

Findings

- **Kelly AFB,** San Antonio, Texas
  - In 2008, 20 homes in 2 areas located off-base were sampled
  - 5 homes selected for further evaluation
    - PCE sub-slab values ranged from 170 to 570 µg/m3
    - indoor values ranged from 0.11 to 0.78 µg/m3
  - In 2009, several additional homes were sampled and a few of the previous homes were retested. No contaminants were detected above levels of concern.

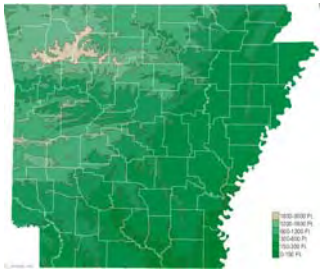
Findings

- **England AFB,** Alexandria, Louisiana
  - Samples collected from sub-slab, crawl space and indoor locations at the former base hospital
  - 2 low level detections of TCE and PCE in the sub-slab samples
  - Subsequent indoor air sampling did not indicate a complete pathway

Findings

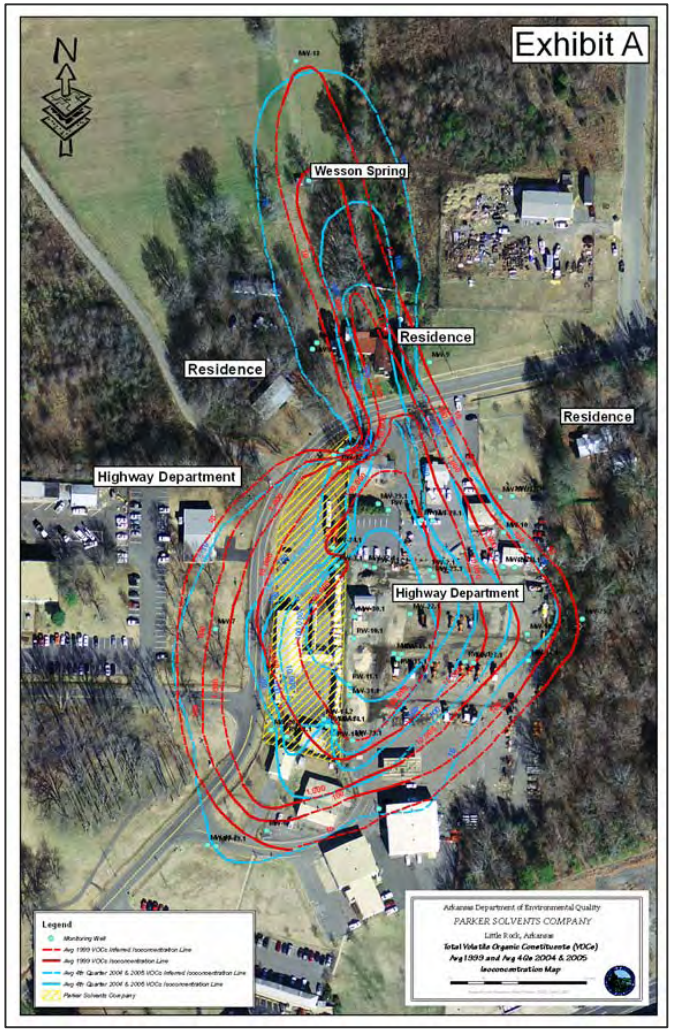
- **Delfasco Forge,** Grand Prairie, Texas
  - Sub-slab and crawl space samples taken at 16 homes and 2 commercial buildings
  - 5 residences selected for indoor air sampling (Summa)
    - All were screened with the TAGA
  - TCE crawl space values ranged from 9.4 to 193 µg/m3
  - Indoor values ranged from 0.59 to 135 µg/m3
  - Ventilation systems installed in several residences
  - Additional sampling and mitigation will be conducted

Findings



- **Parker Solvents,** Little Rock, Arkansas
  - Samples collected from 4 homes, 4 highway dept buildings and Parker Solvents office/warehouses
  - Results indicated some contaminants were above screening levels, but did not appear to be caused by the shallow groundwater plume
  - Majority of detections above screening levels in indoor air samples were Benzene and PCE (not COCs)
  - Detections in areas with elevated ambient air and in office space were adjacent to an open truck bay and police firearms cleaning facility

Parker Solvents Study Area

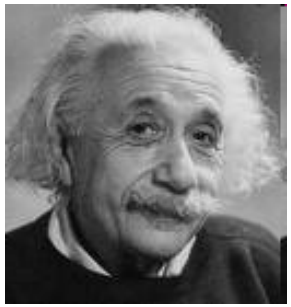


Findings

- **Mueller Copper Tubing Site,** Wynne, Arkansas
  - Samples were collected from 14 properties, which included single and multi-family homes
  - Sampling locations included crawl spaces, slab foundations and a basement
  - Low level detections of TCE were found in a few homes.
  - No contaminants were detected above levels of concern

Delfasco Forge Site

A Few Things to Think About Before You Begin



- Identify the conditions in the field that would cause you to initiate the study.
- Plan to spend lots of time in the community with the homeowners. You will get to know them well.
- Get access agreements early.
- Plan on hosting community meetings before and after.

Introduction to the Delfasco Site

- Metal fabrication and forging operations were conducted at the property for at least 30 years (beginning in the 1960's)

- Groundwater contamination first discovered in 2002

- Facility entered the State's Voluntary Cleanup Program (VCP) in 2003

Introduction to the Delfasco Site

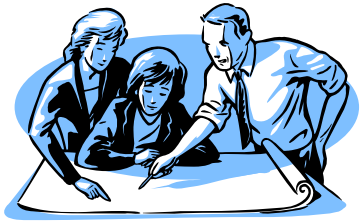
- Delfasco continued delineating and monitoring the ground water plume through 2006 (they stopped when they applied for an MSD)
- TCE is the primary groundwater contaminant and was used to clean parts before delivery
- Facility has been closed for approximately 10 years

The Neighborhood

Community Profile

- Neighborhood is a stable, low income, multi-ethnic community (primarily Caucasian, Hispanic, and Vietnamese)
- Several generations of family members often share a home
- Many families have lived in their homes for over 40 yrs
- Challenges encountered
  - language barriers
  - overall mistrust of the federal government
  - availability of homeowners (who often worked multiple jobs), etc.

Community Outreach



- Outreach involved door-to-door calls to explain the sampling project, encourage participation, obtain access agreements, and discuss sampling results.

- Translators were provided by EPA and the City to assist with both the house calls and public meetings, and all materials were printed in English and Spanish.

- Often, this work was performed on nights and weekends in order to accommodate the residents' schedules.

Community Outreach

- As a testament to the degree of trust built between EPA and the residents, EPA staff were invited by families to join them for dinner.

- During the past year, EPA, ATSDR, TDH and City have hosted 3 public meetings to explain the nature and extent of the investigation, initial sampling results, health implications, and next steps.

- This close involvement with the community has forged a lasting bond which will be invaluable in moving forward with our future efforts in the neighborhood.

Partnerships Leveraged

R6 RCRA Multimedia – Rick Ehrhart, Jeanne Schulze, David Vogler

R6 RCRA Enforcement – Melissa Smith

R6 ORC - Rebekah Reynolds

R6 Superfund – Greg Fife, Bret Kendrick, Beverly Negri

R6 EJ/Tribal Affairs – Nelda Perez

R6 ORD/RS&T – Cheryl Overstreet

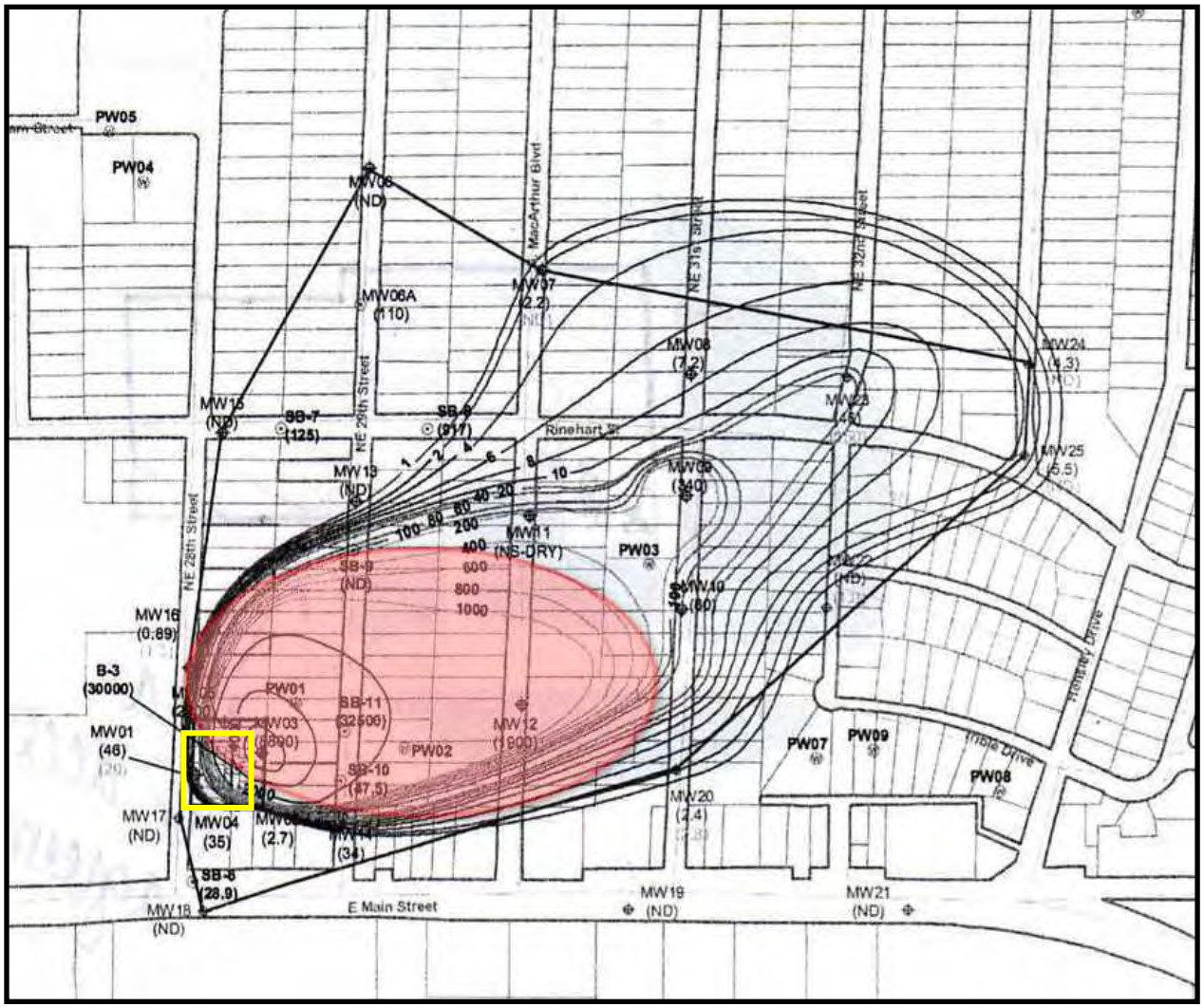
USEPA ERT (and Contractors) – Dave Mickunas

ATSDR – Jennifer Lyke

Texas Dept. of Health – Dr. Carrie Bradford

City of Grand Prairie – Jim Cummings, Cindy Mendez

Ground Water Plume



Delfasco Study Area

Groundwater Plume Facts

- Depth to groundwater is 25+ feet below ground surface
- Primary contaminant of concern is trichloroethene (TCE)
- TCE concentrations in groundwater were as high as 8,800 ppb (2006). Soil concentrations 34,000 ppb onsite.
- Plume covers more than 65 acres and is under approximately 150 homes and businesses
  - 1,100 feet wide; 2,650 feet long

RCRA Program Investigation

- In 2006, the facility applied for a **Municipal Setting Designation (MSD) with the City**. EPA was asked to review the application by the City.

- In 2007, EPA RCRA added the facility to its list of sites for a new pilot study on Vapor Intrusion.

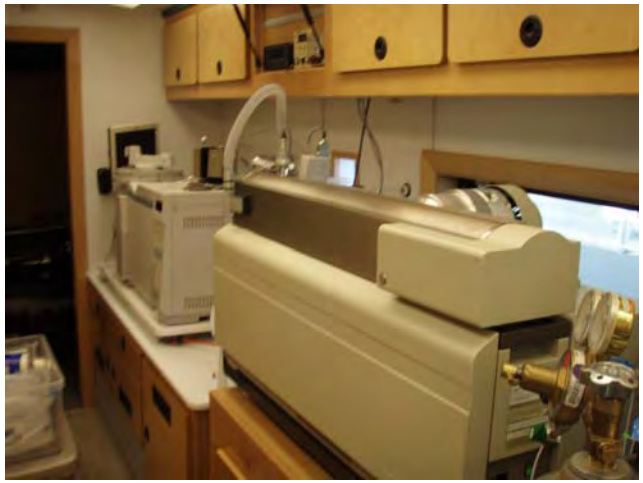
- In March 2008, EPA RCRA conducted sub-slab, crawlspace, and indoor air sampling using the TAGA bus and more traditional summa canisters.

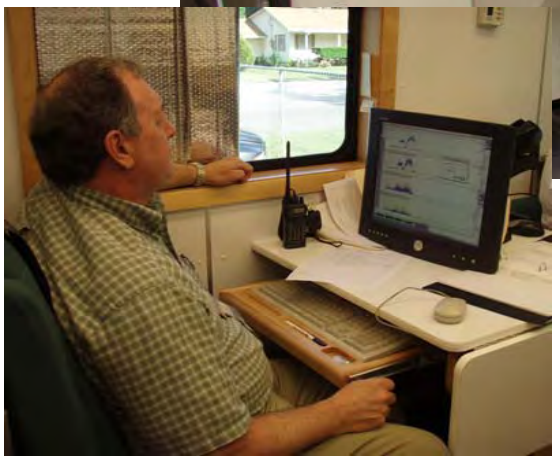
RCRA Actions

- EPA RCRA ordered the facility to conduct an investigation to further delineate and mitigate the vapor intrusion
- Facility claimed it could not comply with the Order and filed for bankruptcy
- EPA RCRA filed a claim against the facility and is working with DOJ to either force the facility to comply with the Order or recover funds through bankruptcy
- Because of an imminent threat to human health, EPA RCRA referred the site to EPA Superfund for removal consideration

Trace Atmospheric Gas Analyzer (TAGA) Mobile Laboratory

Trace Atmospheric Gas Analyzer (TAGA) Mobile Laboratory



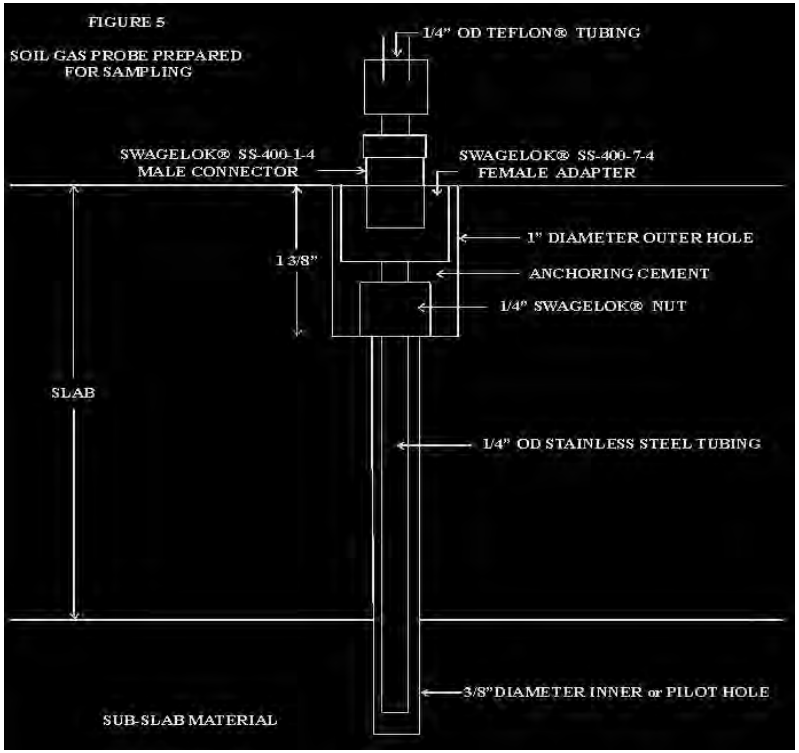


GC/MS

Mobilization

Subslab Sampling Probe Installation

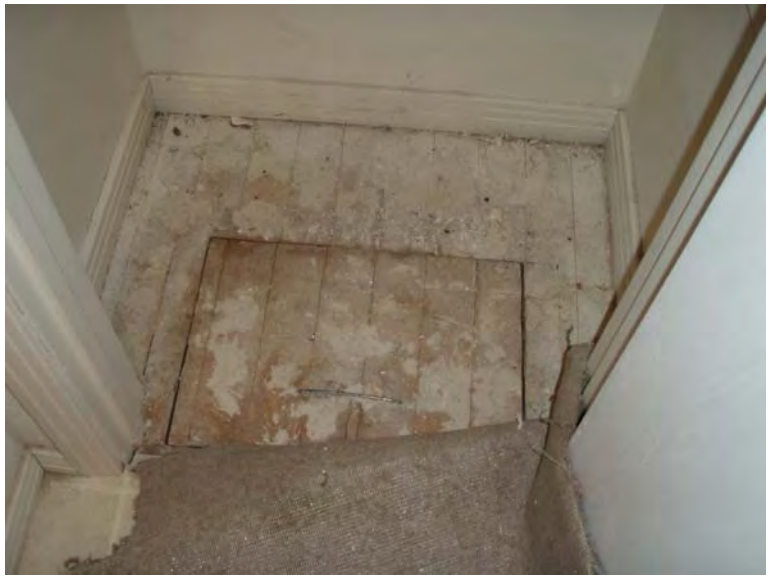
Subslab Ports



Subslab Sampling Probe Installation

Sampling Subslab Ports

Screening Crawlspaces With the TAGA



Placing Summa Canisters in Crawlspaces

Making New Friends in the Neighborhood

Removing Other VOC Sources From Homes

Removing Other VOC Sources From Homes

Indoor Air Sampling
Instructions for Residents

Many of the compounds included in this indoor air-sampling program can be found in a number of different sources in your home. Please follow these instructions in preparation for the sampling. Failure to do so could affect the accuracy of the study.

Please begin these procedures 24 - 48 hours prior to and during the sampling event.

IF POSSIBLE please;

_ WEATHER CONDITIONS PERMITTING, keep doors, windows, vents, etc…closed. Do not operate ventilation fans or air conditioning;

_ Do not use air fresheners or odor eliminators;

_ Do not smoke in the house;

_ Do not use wood stoves, fireplace or auxiliary heating equipment (e.g., kerosene heater);

_ Do not use paints or varnishes;

_ Do not use cleaning products (e.g., bathroom cleaners, furniture polish, appliance cleaners, all-purpose cleaners, floor cleaners);

_ Do not use cosmetics, including hair spray, nail polish remover, perfume, etc;

_ Do not partake in indoor hobbies that use solvents;

_ Do not apply pesticides;

_ Do not store containers of gasoline, oil or petroleum-based or other solvents within the house or attached garage (except for fuel oil tanks);

_ Do not operate or store automobiles in an attached garage;

- Remove potential sources of air contamination from your home. See the attached list;

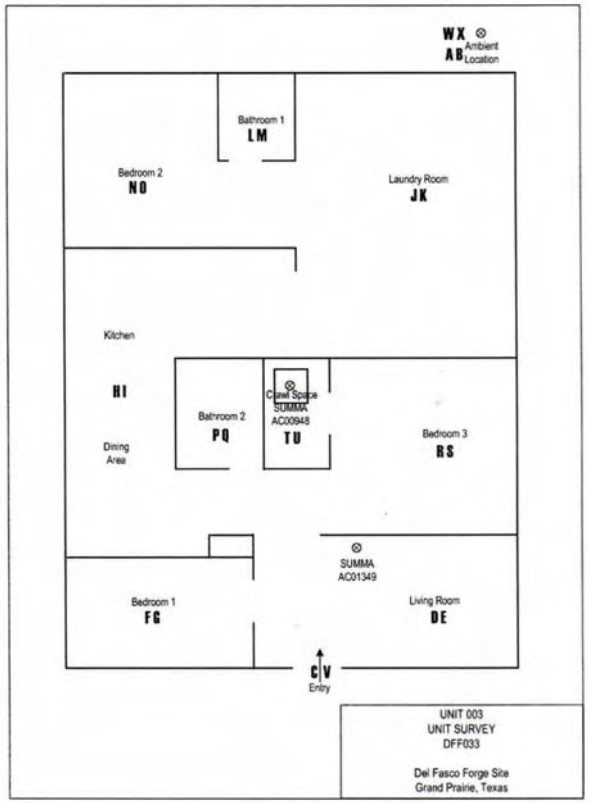
Removing Other VOC Sources From Homes

Please remove the following from your home 24 – 48 hours prior to Indoor Air Sampling:

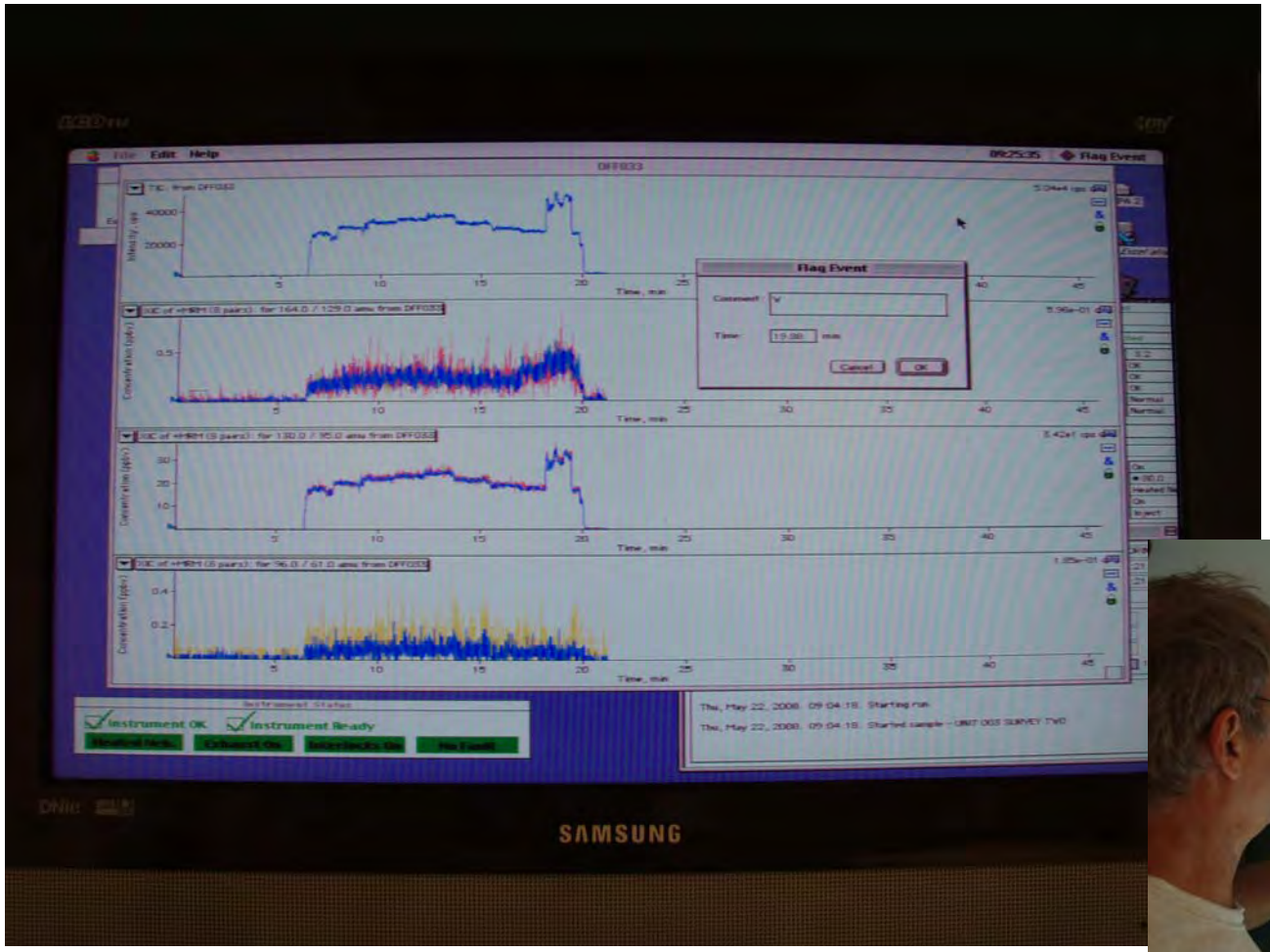
Paints or paint thinners;
Gasoline storage cans;
Gas-powered equipment;
Cleaning solvents;
Air fresheners;
Oven cleaners;
Carpet/upholstery cleaners;
Hairspray;
Nail polish/polish remover;
Bathroom cleaners;
Appliance cleaners;
Furniture/floor polish;
Mothballs;
Fuel tanks;
Perfume/colognes;
Hobby supplies (solvents, glues, lacquers, photography chemicals);
Scented trees, wreaths, potpourri

Screening Indoor Air with the TAGA

TAGA Monitoring for Indoor Air



TAGA Monitoring for Indoor Air



Converting Analytical Results

ppbv = ($\mu g/m^3$ x 24.45) / MW

$\mu g/m^3$ = (ppbv x MW) / 24.45

TAGA Monitoring for Indoor Air

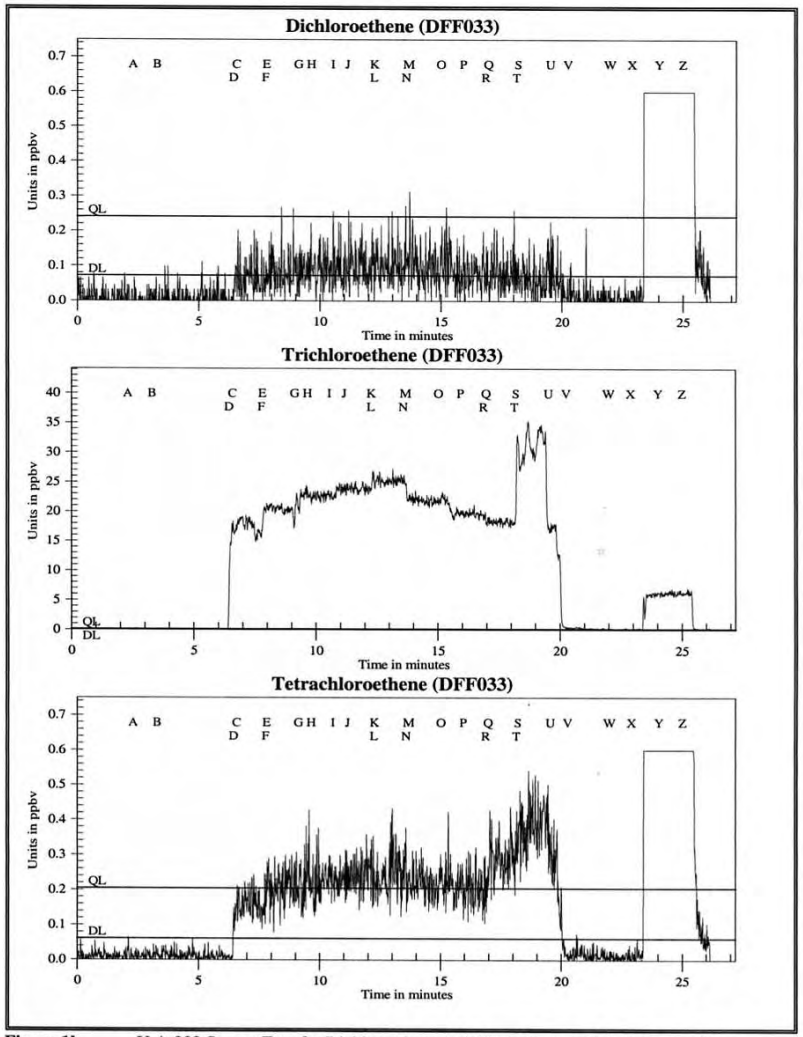


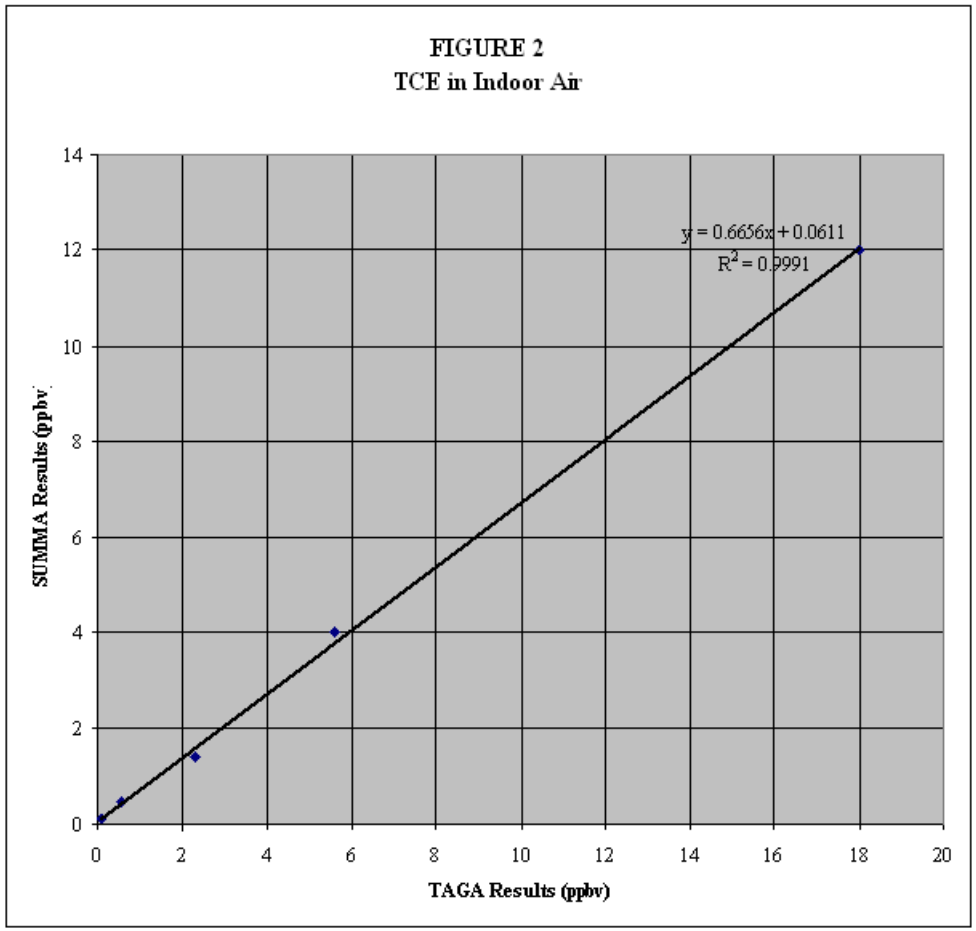
Figure 1b Unit 003 Survey Two for Dichloroethene, Trichloroethene, and Tetrachloroethene

Figure 1b

TAGA File Event Summary
File: DFF033 Acquired on 22 May 2008 at 09:04:20
Title: Unit 003 Survey Two

Flag	Offset Time	Offset Sequence	Description
A	2.1	149	Start of the pre-entry ambient
B	3.1	220	End of the pre-entry ambient
C	6.4	452	Entering the unit
D	6.6	470	Start of the living room
E	7.6	540	End of the living room
F	7.9	560	Start of bedroom one
G	8.9	632	End of bedroom one
H	9.4	669	Start of the kitchen/dining room
I	10.4	740	End of the kitchen/dining room
J	11.0	782	Start of the laundry room
K	12.0	853	End of the laundry room
L	12.4	878	Start of bathroom one
M	13.4	951	End of bathroom one
N	13.8	975	Start of bedroom two
O	14.8	1049	End of bedroom two
P	15.8	1117	Start of bathroom two
Q	16.8	1187	End of bathroom two
R	17.0	1207	Start of bedroom three
S	18.0	1277	End of bedroom three
T	18.3	1295	Start of the crawl space
U	19.3	1368	End of the crawl space
V	20.0	1419	Exiting the unit
W	21.7	1537	Start of the post-exit ambient
X	22.7	1606	End of the post-exit ambient
Y	23.8	1685	Start of the 30 mL/min spike
Z	24.8	1757	End of the 30 mL/min spike

Correlation between TAGA and Summa



Taking Ambient Air Readings

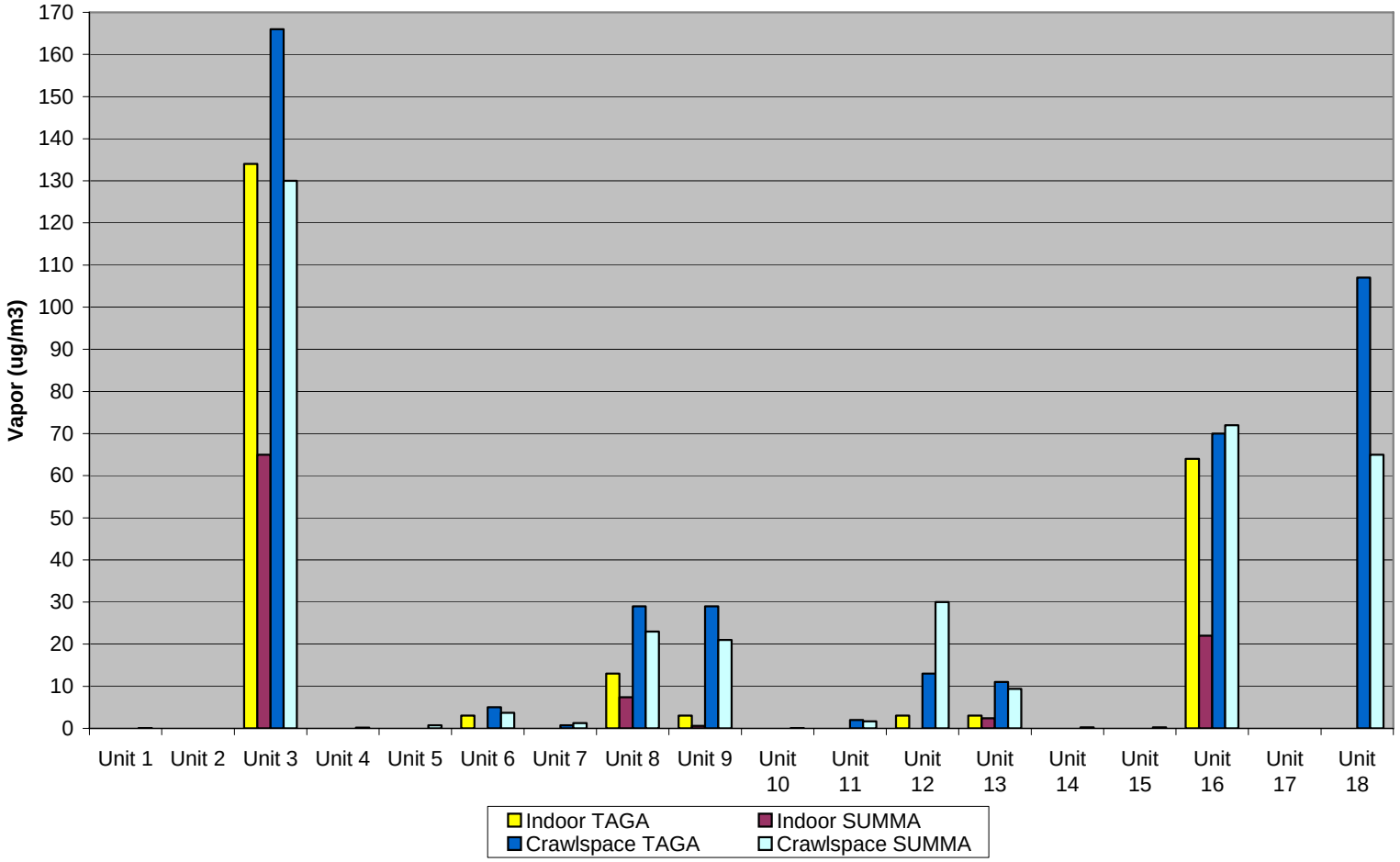
Indoor & Outdoor Air Sampling with Summa Canisters

Long Days… Short Nights…

RCRA Investigation Results

- Of the 18 homes or businesses sampled for vapor, i.e., sub-slab / crawlspace and indoor air, 10 had detections 1 ug/m^3 or greater
- The highest indoor air concentration measured was 135 ug/m^3
- The highest crawlspace measurement was 193 ug/m^3
- EPA's 7003 Order mitigation range: 1.2 ug/m^3 for cancer effects and 10 ug/m^3 for non-cancer

RCRA Investigation Results

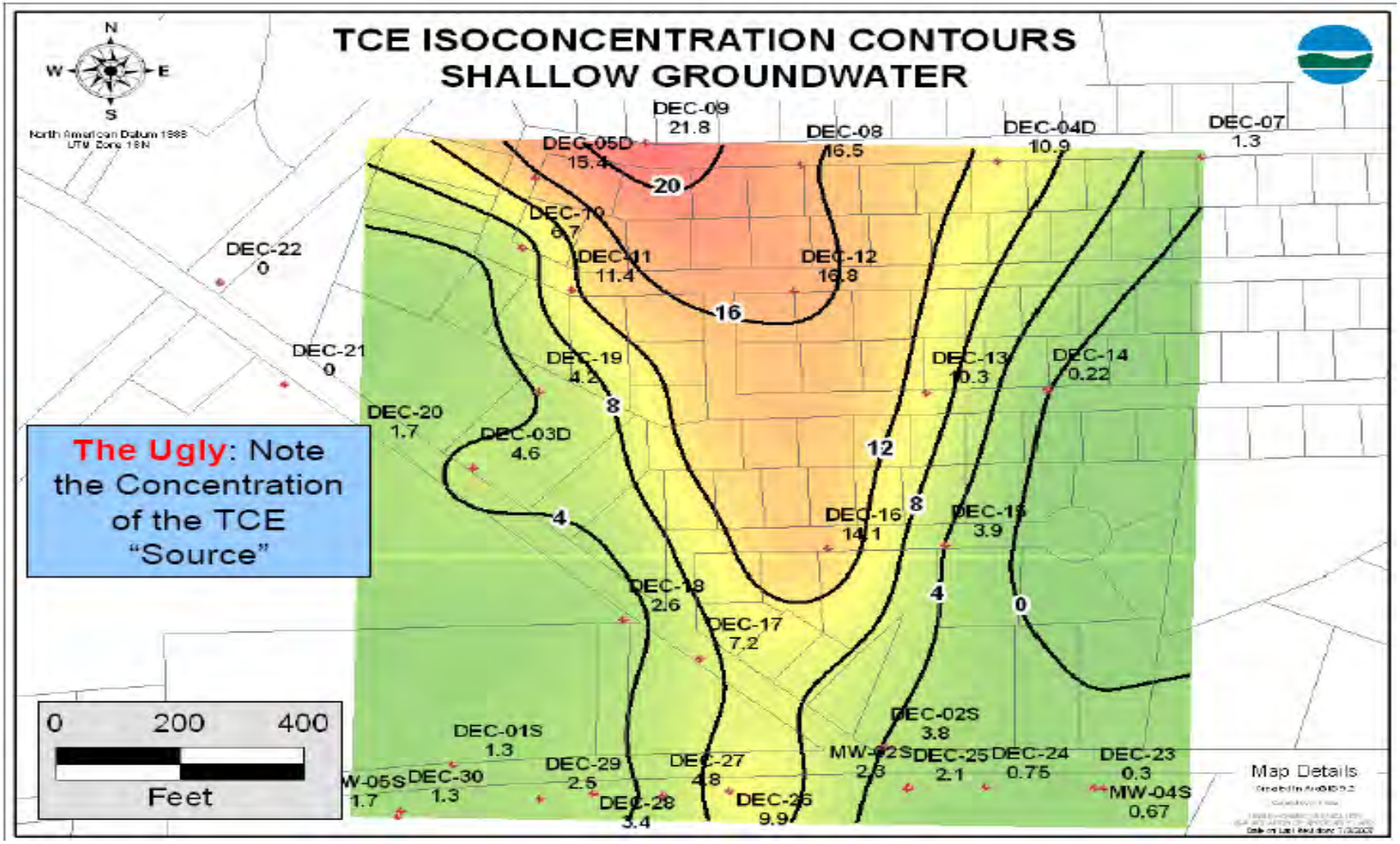


RCRA Investigation Results

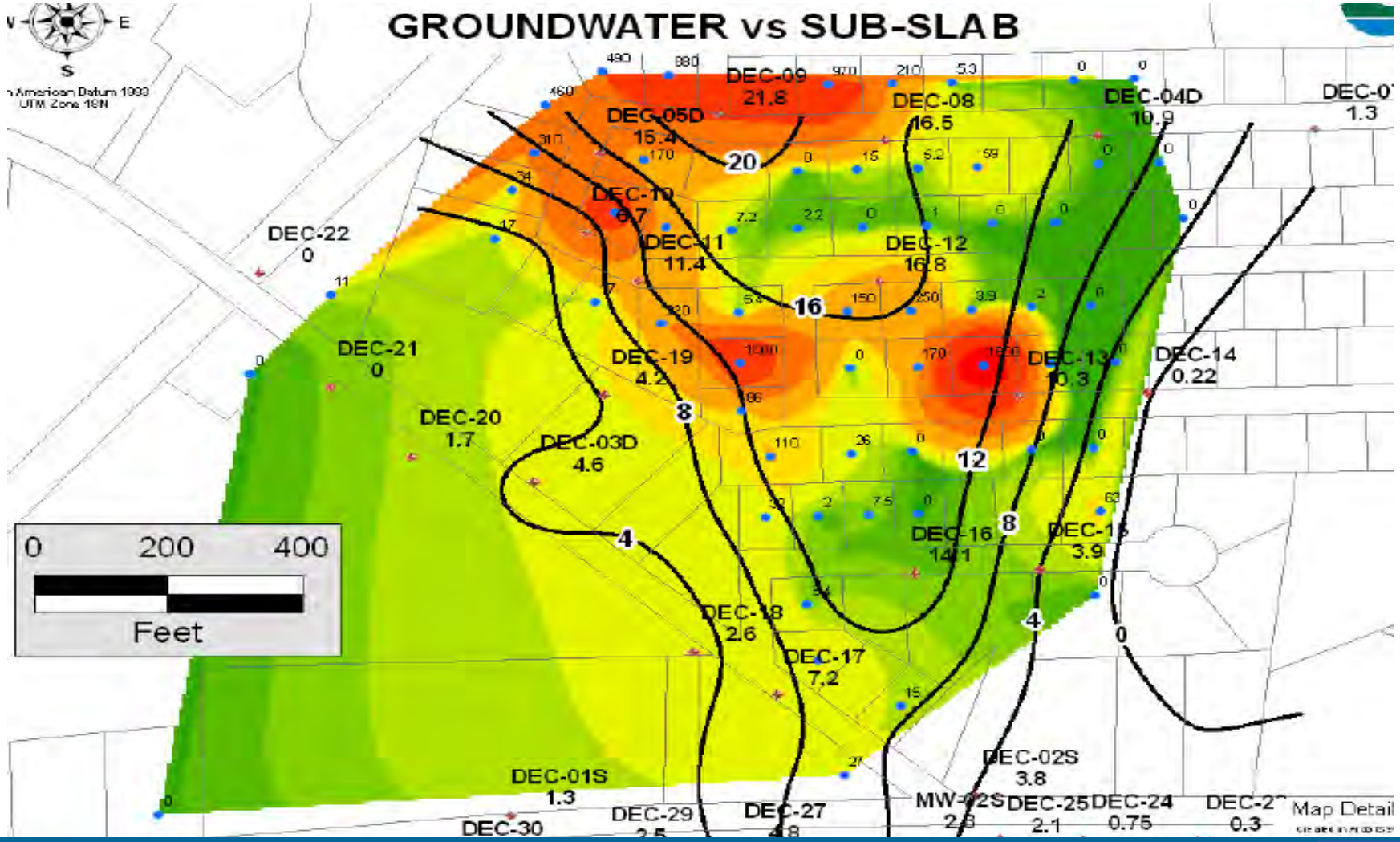
- Map shows the location where contaminants were detected in crawl spaces and indoor air

RCRA Investigation Results

Endicott Site, NY



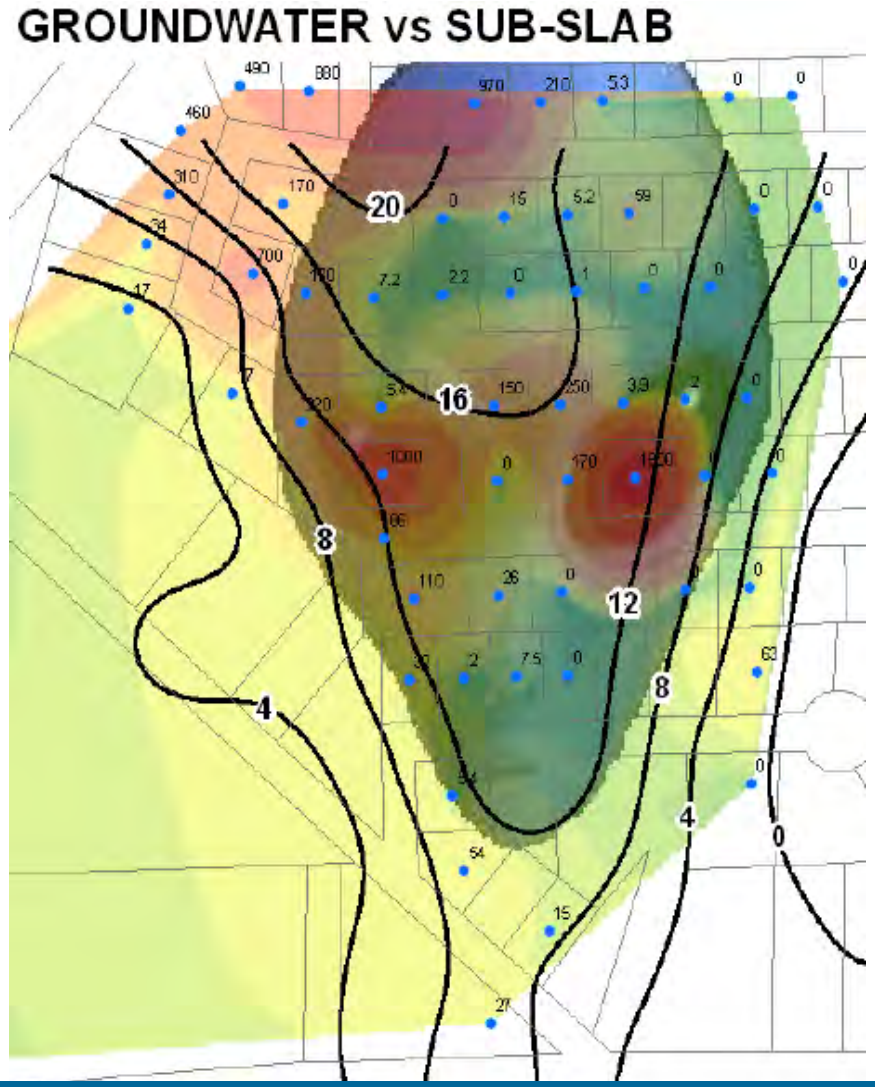
Endicott Site, NY



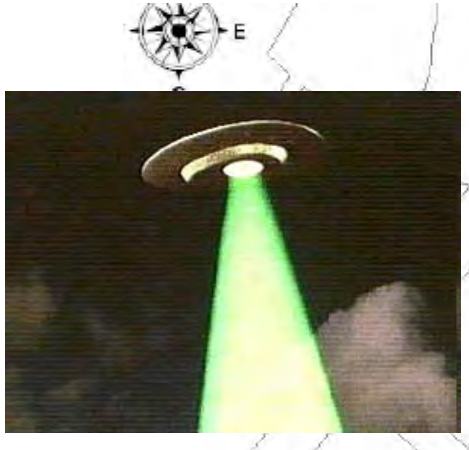
Patchy FOG CSM

Endicott Site, NY

A pattern between groundwater contamination and soil gas begins to emerge



Endicott Site, NY



Alien Concepts

Sites with low ppb TCE in groundwater could be a problem

Soil gas is not a reliable predictor of subslab vapor concentrations

VI pathway is like a patchy fog not a blanket

Remediation Approach

Crawlspace / Indoor Air (ug/m³)	Priority
>10	First
5 – 10	High
1.2 – 5 ug/m3	Site-specific
<1.2 ug/m3	Low

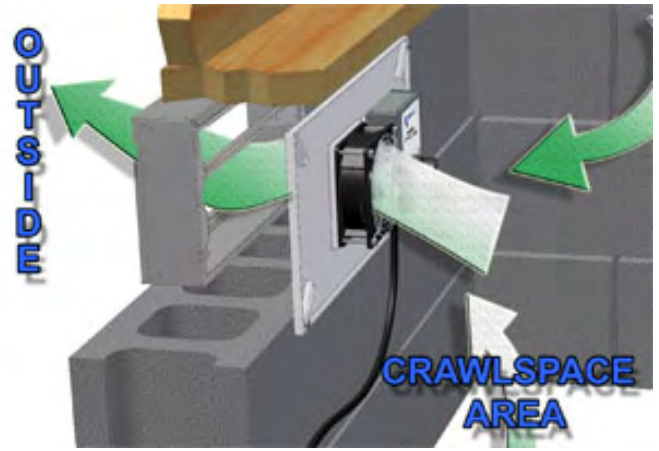
Residential Screening Levels For Indoor Air Samples

Chemical	Indoor Air ug/m^3	Molecular Weight	24.5/Molecular Weight	Indoor Air ppbv
Tetrachloroethene (PCE)	0.41	166	0.1476	0.0605
Trichloroethene (TCE)	1.2	131	0.187	0.2244
1,2-dichloroethene	37	97	0.2526	9.345
Vinyl chloride	0.16	63	0.3889	0.0622
Benzene	0.31	78.1	0.313	0.0970
Toluene	5200	92	0.266	1384.8
Ethylbenzene	0.97	106	0.231	0.2241
Xylene	100	106	0.231	23.11

Superfund Removal Actions

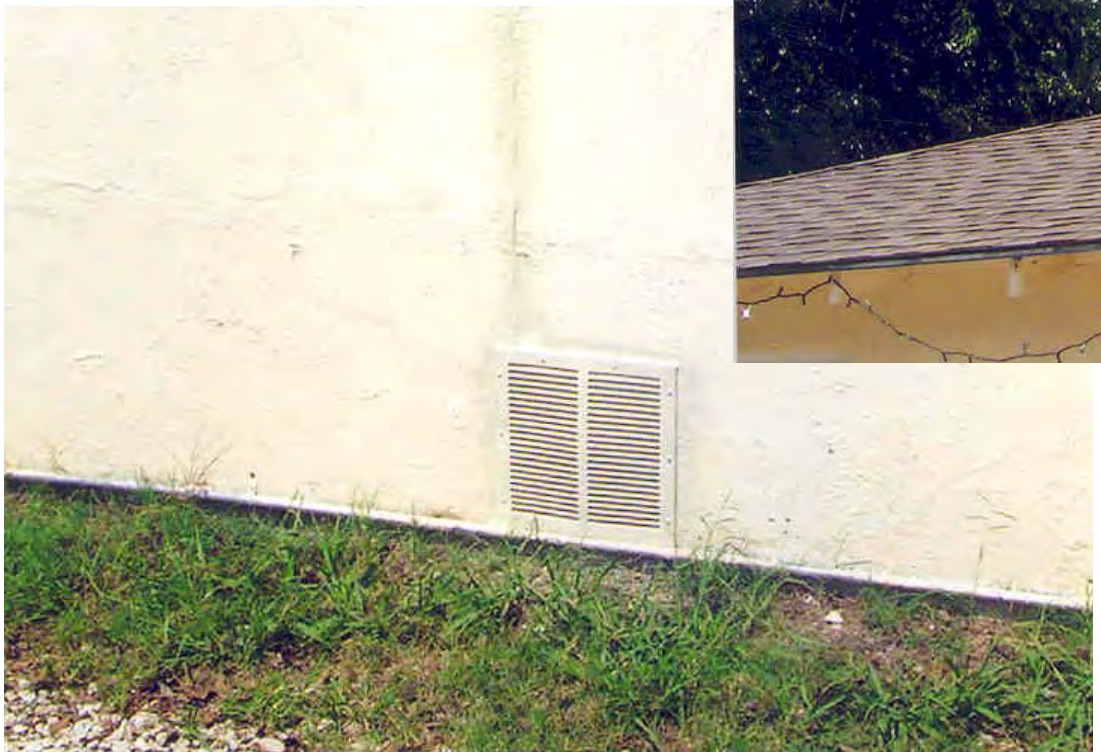
- Immediately contacted the owners of homes that exceeded their short term action level and offered to install mitigation systems on their homes

- Installed mitigation systems consisting of solar-powered venting (fans) on the crawlspaces



- Initiated an investigation of the area overlying the groundwater plume (passive soil vapor and gw sampling)

Superfund Removal Action Mitigation



Other Vapor Mitigation Options

Superfund Removal Investigation

- Installed 86 passive soil gas samplers throughout the area overlying the ground water plume

- Samplers were installed in the rights of ways with approximately 50 feet between the sample devices

Removal Investigation

Removal Investigation

- Passive soil gas samples were analyzed for volatile organic compounds using a modified version of SW846, Method 8260B
- TCE was detected in 13 of the 86 passive soil gas samples collected
- Soil gas shows that a vapor plume is present but is not the best indicator of where vapor will be present in indoor air
- Subslab or crawlspace is a better predictor, both indoor air samples and subslab are preferable

Conclusions

- Contaminants have been detected in soil gas, air within crawl spaces, and indoor air

- It appears the residents with the highest risk for exposure to vapor intrusion are those that reside over the portion of the groundwater plume with the highest concentrations of TCE, but additional monitoring would be required to confirm.

- EPA will encourage City of Grand Prairie or nonprofit to implement EPA work plan for Vapor Intrusion Mitigation of up to 100 homes (Presumptive Approach vs. Extensive Sampling) along with groundwater remediation

Take Away Messages

- **THE UGLY**
  - The VI pathway is complex, reliable prediction is difficult
- **THE BAD**
  - Even low concentrations of VOCs can have VI impacts
- **THE GOOD**
  - Mitigation is usually straight forward and often cheaper than investigatory studies

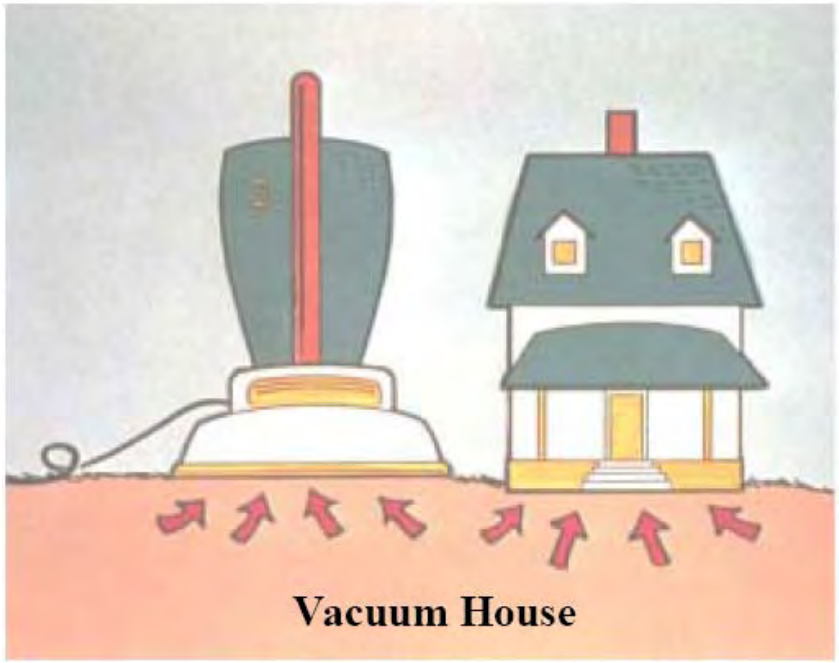
Take Away Messages

- **Vapor Intrusion Evaluation Goal -** Efficiently and effectively identify and address impacted structures

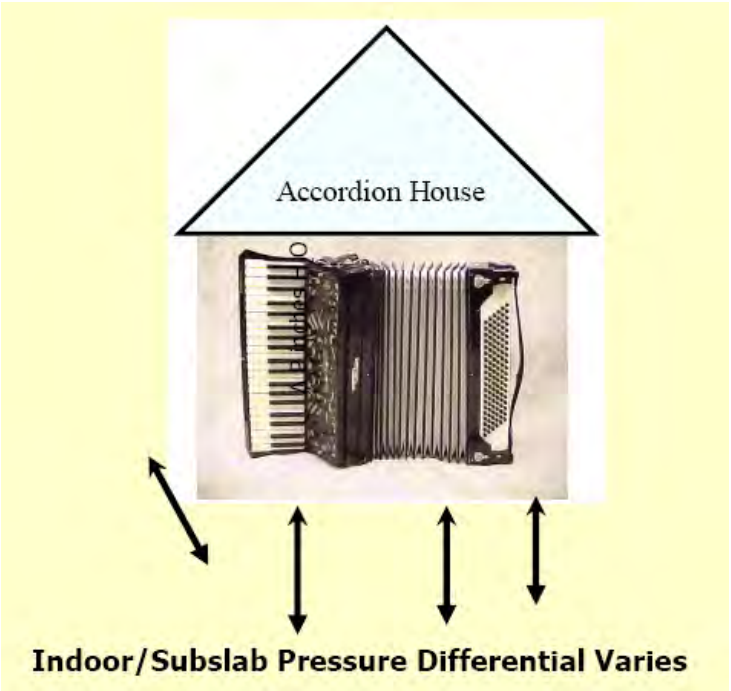
  - Determine the nature and extent of the contaminant source (often this data already exists)
  - Determine the extent of potentially impacted structures
  - Short term (take necessary actions to address exposures)
  - Long term (take necessary actions to address the source)

Take Away Messages

Classic Conceptual Model

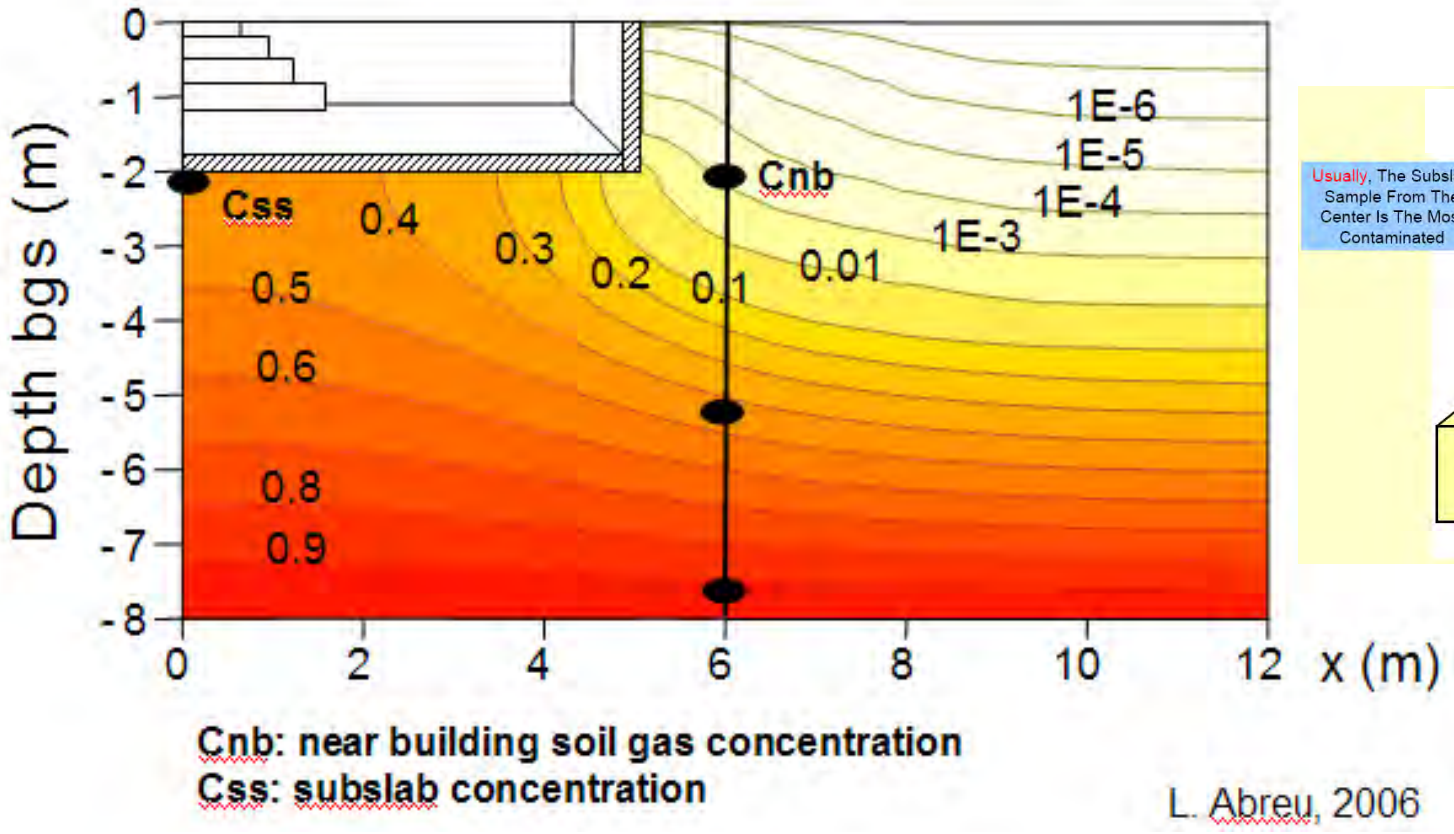


Patchy Fog Conceptual Model



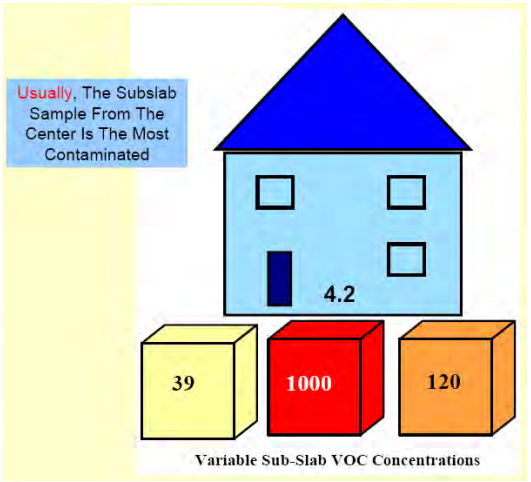
Take Away Messages

- Soil gas values historically have not been good predictors of subslab vapor concentrations



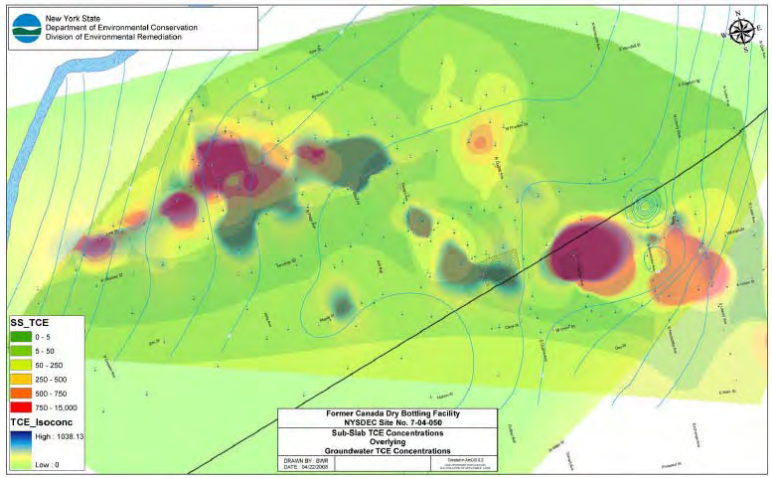
Cnb: near building soil gas concentration
Css: subslab concentration

L. Abreu, 2006



Take Away Messages

- Area of <u>subslab impacts generally mirrors area of groundwater impacts</u>, but
- <u>Not all areas above the plume are impacted</u>
  - Approach: blanket mitigate structures above groundwater impacted area
  - Increase sampling density in uncertain areas



Take Away Messages

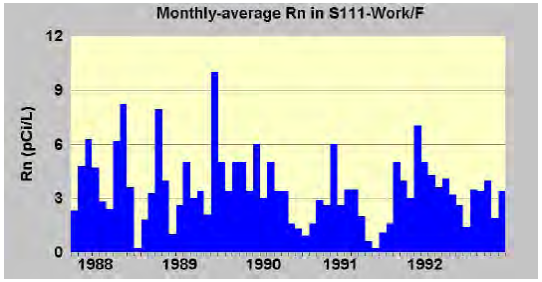
Lessons from 30 years of EPA et al Radon Studies

- External sampling cannot represent:
  - The influence of building factors (e.g., type of construction, staircases, HVAC, etc.)
  - The interaction of the building with meteorology (rainfall, temperature, wind) entry driving forces
  - The influence of occupant behaviors (opening/closing doors and windows, etc.)

Take Away Messages

Lessons from 30 years of EPA et al Radon Studies

- Only Indoor Air Samples Integrate Three Major Sources of VI Variables:
  - Subsurface source and migration factors
  - Building factors
  - Above ground environmental factors



- If you want to know what is in indoor air then you are going to have to sample it. The longer the sample the better it represents the actual long term average due to temporal variability.

Questions?

Contact Information

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RCRA Corrective Action

EPA Region 6

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214-665-6765